Evaluation of the Intersection Confirmation Light With Targeted Enforcement to Reduce Red Light Running Violations at Freeway Ramp Intersections

By

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DEDICATION

This thesis is dedicated to my beloved parents, who have been my eternal rock and source of refuge. I also dedicate this work to my sister for always being there for me. I couldn’t be more grateful to almighty for blessing me with such a great family. I could not have made this far without you.

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ABSTRACT

Red Light Running (RLR) at signalized intersections continues to be a safety concern for many communities in the United States. The Insurance Institute for Highway Safety (IIHS) reported a total of 683 fatalities and 133,000 injuries in 2012 due to crashes involving RLR. There are many strategies to mitigate RLR violations that can be classified as engineering, enforcement, or education techniques. Previous studies have reported positive impacts of these strategies in reducing RLR. Intersection confirmation lights with targeted enforcement are a low-cost measure to reduce RLR in communities where automated enforcement is not practical or feasible. Some studies have shown the effectiveness of confirmation lights in reducing RLR at four-leg signalized intersections. This research study focuses on evaluating confirmation lights to enhance enforcement at on-ramp signalized intersections. Operations of on-ramp intersections are different than four-leg intersections, as the drivers may be more likely to run the red light and join the freeway. Police officers find these intersections difficult to enforce from the ramp as they cannot see the traffic signals. Adding confirmation lights can change that.

Confirmation lights were deployed at two on-ramp intersections in Overland Park, Kansas. Traffic were observed at the treatment sites, and at five other control intersections. Traffic data were recorded before deployment, one month after, and three months after installation of the confirmation lights. A total of seven intersections were recorded for 24 hours on Tuesdays, Wednesdays, and Thursdays for a total of 1512 hours of traffic video. A z-test of proportions was used to determine if the changes in RLR violation rates from the before period to the after periods were statistically significant at the 0.05 level of significance. Violation time into red (how long it took a driver to run a red light after the red signal indication) was used as a secondary performance measure to evaluate the confirmation lights. A chi-square test of independence was used to analyze the violation times into red at the 0.05 level of significance.

Analysis showed a 60.4 percent reduction in the RLR violation rate at the treatment sites and a 31.8 percent reduction at the control sites one month after installation of the confirmation lights. The three months after study indicated a 56.9 percent decrease in violation rates at the treatment sites and 60.16 percent reduction at the control sites. At the 0.05 level of significance, the one month and three month reductions at the treatment sites were statistically significant whereas only the three months reduction were statistically significant at the control sites.

A chi- square test was conducted for time into red which was statistically significant for the one month and three month violations for both the treatment and the control sites. This indicates a relationship between confirmation lights with targeted enforcement and the driver behavior for time into red. It should be noted that, the confirmation lights were not visible to the driver, however the driver could see the police officer located on the on-ramp.

Reduction in RLR violation rates were observed at control site. A chi-square test for goodness of fit was performed on data obtained from Overland Park Police Department on the number of officers deployed and citations written to check if the structure of enforcement changed during after study period causing reduction of violation rates at the control sites. It was found at the treatment sites that less number of officers were deployed during after study period and less citations were made in after study period compared to before study period. At the control sites, it was found that less officers were deployed during after study period compared to before study period, however the change in citations made were statistically not significant during both study periods. Hence the reductions at the control sites could be a possible halo effect from treatment sites effectively converting the control sites to spillover sites. In conclusion, the findings of this research study indicated that confirmation lights with targeted enforcement have a positive effect in reducing RLR violations at on-ramp signalized intersection.

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CHAPTER 1. INTRODUCTION

Red Light Running (RLR) is an event where a vehicle enters an intersection when the red signal is indicated which cause hundreds of fatalities and injuries every year. The Insurance Institute for Highway Safety reported that in 2012, 683 fatalities and an estimated 133,000 were injured in crashes that involved RLR (*1*). More than half of those fatalities were pedestrians, bicyclists, and occupants in other vehicles, who were hit by a vehicle running a red light. Additionally, it was estimated that RLR crashes at signalized intersections cause a social economic loss of approximately $14 billion dollars annually (*2*).

A study by Mohamedshah et al. showed that 16 to 20 percent of all urban crashes involved signalized intersection RLR (*3*). The most common crashes were those involving drivers who ran red lights, STOP signs, and other traffic controls devices. Injuries occurred in 45 percent of the crashes in which vehicles ran a red light.

Considerable efforts have been taken to mitigate RLR in the United States and other developed nations. However, there is a need to continue RLR research in communities where money and political constraints restrict the use of automated enforcement to increase local safety. From the literature it has been found that limited research has been conducted to evaluate the effectiveness of confirmation lights on signalized intersections.

Freeway ramp intersections operate differently compared to four-leg intersections. Unlike four-leg intersections, if a driver has violated the on-ramp intersection, they could be miles ahead on the freeway within a few minutes, among high volumes of traffic. Also the targeted enforcement at these on-ramp intersections has been found to be difficult to apprehend the violator on the freeway, posing a safety issue for the officers and other vehicles. Driver may be more motivated to violate red light at on-ramp because of several factors: lack of experience of seeing officers patrolling ramps, and the potential pay-off for violating that they could be miles down the freeway before the next green phase.

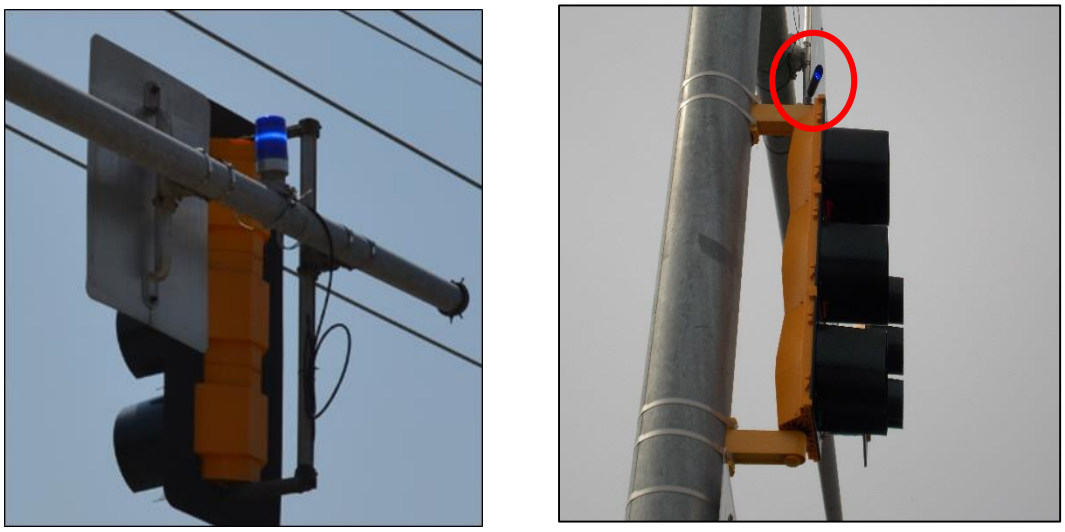
For enforcing on-ramp intersections in communities which rely on targeted enforcement, the best practice is to apprehend the violator before entering the freeway. Targeted enforcement has been proven to be effective, however enforcing such intersections with efficiency and safety require two or more officers. One officer would be stationed upstream to monitor the traffic signals and the

other on the ramp to write tickets to RLR violators. With the help of confirmation lights the number of officers required to enforce an intersection is reduced to only one on the ramps. The confirmation lights activate when the signal it is associated with turns red, indicating to the officer present on the ramp of any violation.

There exists a wide range of potential countermeasures to reduce RLR, including:

- Traffic signal timing modification;
- Physical geometric and operational improvements;
- Advance warning for drivers that the signal is about to change;
- Automated enforcement;
- Targeted enforcement; and
- Public education.

Communities without automated enforcement rely on low-cost countermeasures and traditional targeted enforcement to reduce RLR crashes at signalized intersection. An example of low-cost enforcement countermeasures combined with targeted enforcement is shown in Figure 1.



(A) (B)

Figure 1. Varieties of confirmation lights (4)

1.2 Research Objective

The objective of this research study was to evaluate the effectiveness of the confirmation lights with targeted enforcement at on-ramp signalized intersections to reduce RLR in Overland Park, Kansas. This objective was accomplished by conducting RLR violation studies before and after installation of confirmation lights with targeted enforcement as the primary performance metric at two treatment intersections (where confirmation lights were installed) and five other control intersections (where no lights were installed). RLR violation rates were used as a crash surrogate to assess the effectiveness of the confirmation lights with targeted enforcement. The secondary performance metric used was violation time into red to study the change in driver behavior due to presence of visible targeted enforcement.

1.3 Thesis Organization

This thesis is divided into seven chapters. Chapter 1, Introduction, presents a brief background of RLR and discusses why on-ramp intersections operate differently. It also presents the research objective of this study. Chapter 2 summarizes the literature pertaining to this research study. It also discusses some countermeasures that have been implemented and evaluated by other researchers. Chapter 3 introduces the problem statement and need for this research. Chapter 4 outlines the methodology used for gathering and analyzing the video data from the study intersections. Chapter 5 presents descriptive statistics and factual data obtained from the video reduction. Chapter 6 presents the analysis of RLR violation data using statistical methods and discusses they key findings. Chapter 7 presents the general conclusions, contribution to highway safety, and future studies.

CHAPTER 2. LITERATURE REVIEW

This chapter reviews current literature on targeted enforcement and confirmation lights. It cites various information from articles, research journals, websites and other relevant publication pertaining to targeted enforcement and RLR.

2.1 Red Light Running

The definition of RLR is based on whether "permissive yellow" or restrictive yellow" laws are in effect. Under the "permissive yellow" rule, according to the Federal Highway Administration (FHWA), a driver can legally enter an intersection during yellow but a violation would be considered if the driver entered the intersection after the indication of red (*5*).

Under the "restrictive yellow" rule, a driver can neither enter nor be in the intersection during the yellow interval and violation occurs if the driver has not cleared intersection after the onset of red. In most states where right turns on the red interval are allowed, the vehicle must come to a complete stop before making a right turn, and failure to do so is considered a violation (*4*).

2.2 Red Light Running Countermeasures

Many studies have investigated the effectiveness of RLR programs/countermeasures such as engineering, education, and enforcement. Results from these studies have shown a positive effect in reducing RLR violations and many communities across the United States have adopted these countermeasures. Studies to examine the possible causes of RLR at particular locations should be performed before adopting any of the countermeasures in order to effectively mitigate any potential problems (*6*).

Table 1 shows the possible causes of RLR and their appropriate countermeasures (*7*).

Table 1. Appropriate Countermeasure to RLR (*7*)

Possible Cause of RLR	Engineering Countermeasure Categories			Enforcement
	Signal Operation	Motorist Information	Physical Improvement	
Congestion or excessive delay	✓		✓	
Disregard for red				✓
Judged safe due to low conflicting volume			✓	✓
Judged safe due to narrow cross street				✓
Judged safe due to following <2 sec behind vehicle in front				✓
Expectation of green when in platoon	✓			
Downgrade steeper than expected	✓			
Speed higher than posted limit	✓			
Unable to stop (excessive deceleration)	✓			
Pressure by closely following vehicle	✓			
Tall vehicle ahead blocked view		✓		
Unexpected, first signal encountered		✓		
Not distracted, just did not see signal		✓		
Distracted and did not see traffic signal		✓	✓	
Restricted view of signal		✓		

Note: "✓" Indicates the appropriate countermeasure

Table 1 shows appropriate countermeasures for the possible causes of RLR. An enforcement countermeasure should be considered when drivers disregard the traffic control and use their judgment when crossing an intersection. The following section presents a summary of the studies conducted on enforcement countermeasures pertaining to the objectives and methodologies of this research which are: 1) targeted enforcement, and 2) confirmation lights.

2.3 Enforcement Countermeasures

Enforcement countermeasures are considered as those where police officers, or a device which acts as a surrogate to a police officer are used. Several studies have been conducted to show the effectiveness of these two countermeasures or combination of the countermeasures in reducing RLR at signalized intersections.

2.3.1 Automated Enforcement

As of April 2015, 459 communities had red light camera programs and 134 communities have speed camera programs (*8*). Automated enforcement is a highly effective way to enforce RLR at a signalized intersection. In a study by Fitzsimmons et al., they found 44 percent, 90 percent, and 40 percent reductions in total, right angle and rear-end crashes, respectively in Council Bluffs, Iowa (*9*). Similarly, a study conducted in North Carolina at red light camera equipped intersections showed a 17 percent reduction in total crashes, a 22 percent reduction in RLR-related crashes, a 42 percent reduction in angle crashes, and a 25 percent reduction in rear-end crashes (*10*).

Hallmark et al. found in their study while evaluating RLR cameras in Cedar Rapids, Iowa that over 120 violations occurred from zero to less than one second into the red phase, while 60 violations occurred 2.5 seconds into the red phase during the pre-ticket evaluating period (*7*).

2.3.2 Targeted Enforcement

The primary objective of targeted enforcement is to reduce traffic violations, i.e. speed violations or RLR violations, either through an increase in citing violations or with the presence of enforcement units at a site. Targeted enforcement is used at an identified corridor or site where RLR violations have been identified as a problem through a crash and/or violation study. With the help of this technique one officer is stationed upstream of the intersection to observe the violation and sends a radio message to another officer situated downstream of the intersection or ramp to pull over the violation and issue tickets if necessary.

In 1997, Al-Tarawneh conducted research to investigate the effectiveness of targeted police enforcement in reducing the rate of red light violations at signalized intersection (*11*). The researcher's primary objective was to evaluate the effectiveness of public information and education programs coupled with targeted enforcement, concerning the hazards of increasing RLR at signalized intersections. This objective was achieved by obtaining video data for six signalized intersections in Lincoln, Nebraska; additionally a total of 1,185 drivers were surveyed to assess attitudes to yellow and red signal indications before and after an education program has implemented for one month. Video data were collected at morning peak hours of 7:00 a.m. to 9:00 a.m., off peak data were collected between 11:00 a.m. to 1:00 p.m., and afternoon peak data were collected between 4:00 p.m. and 6:00 p.m.

Data extracted from these video recording were elapsed time after the onset of the yellow signal at which vehicles entered the intersection, the average speed of the intersection area, the average number of yellow entries per cycle, the average number of red light violations per cycle, and the average number of vehicles entering the indecision zone after the onset of yellow signal phase. ANOVA tests were performed on all the variables to determine if there were statistically significant differences between the non-enforced and enforced sites, before and after the campaign. The level of significance was selected as 0.05. It was found that there was a significant reduction in the number of red light violators and mean entry time before and after the campaign, however, no significant difference was found between the enforced and non-enforced study sites.

Baugley in 1988 pointed out that there were three groups of drivers that "run the red light" (*12*):

a) Those who could have cleared the intersection before the red, but were delayed by slower traffic in front of them or either by their own indecision.
b) Those in the dilemma zone, which could neither stop comfortably nor clear the intersection safely before the onset of the red signal; and
c) Those who could have stopped comfortably, but chose to run the red light intentionally.

The crashes resulting from the first two types could be minimized by proper signal timing designs. The third type, however, had to be controlled by targeted enforcement and driver education.

In 1985, Wortman et al. studied five signalized intersections in the Tucson metropolitan area to determine the impact of visible police enforcement on driver and traffic characteristics associated with changes in the yellow interval (*13*). They conducted a before and after study using time lapse photography. They found out at first that visible police enforcement had no significant influence on driver behavior and traffic characteristics but the percentages of vehicle running the red light decreased considerably when a marked vehicle was present at the site. Results indicated that the percentage of drivers running the red light decreased from 18.4 percent to 8.6 percent with the presence of a police vehicle. Also, it was found that the distance from the intersection at the onset of yellow signal, for the last vehicle through the intersection, was significantly decreased.

Miller and Generowicz indicated in their study that to apprehend the traffic control violators, it is usually necessary for continuity of evidence to be proven (*14*). To achieve this, law enforcement officers had considerable difficulty in enforcing regulations. For being confident of securing a conviction, they would be required to adopt one of the following procedures:

a) Stationing one officer upstream and one officer downstream or the target location. The upstream officer acted as an observer and the downstream officer was the one who intercepted the violators.

b) Station an officer on the approach to a target intersection. When a motorist violates the traffic control device, the officer attempted to apprehend the motorists by pursuit.

Disadvantages of both the methods were reported in their studies. The disadvantage of the first method was the necessity to use several officers for a particular site, thereby increasing the requirement of much needed officer manpower, while the second method had the problem of pursuing a vehicle which had run a red light. Officers running a red light to pursue violators increase the possibility of being involved in a crash with cross-street traffic.

Cooper evaluated the effect of varying enforcement levels on violation and conflict areas (*15*). Six signalized intersections were selected as the study sights which were enforced with different levels, i.e. one or two officers for one, two, or three hours per site per day. Police officers with their motorcycles were made highly visible at all times and maintained their normal function of issuing warnings or tickets to offending drivers. It was found out that with the help of visible enforcement, a significant decrease of 25 percent was reported in the number of violations

committed by motorists. From this study it was also shown that after the enforcement was terminated, driver behavior was found to revert to its original pattern. It was concluded that an assigning officer to an intersection for one hour per day produced a significant improvement over the no enforcement condition, however increasing the number of officers to two per intersection for three hours a day reduced violation occurrence only slightly above the first level of decrease.

Zaal in 1990, indicated in his review that the advantage of targeted enforcement compared to camera enforcement was that red light violators could be apprehended immediately after the violation. According to his review the immediacy of citations had a more lasting effect on driver behavior than the receipt of a camera-based citation several weeks after the offense (*16*).

2.3.3 Confirmation Lights

Confirmation lights are low-cost, small lights mounted back of the traffic signal mast arm or top or bottom of the signal head. This light is sometimes referred to as "Red-Signal Enforcement Lights" or "Red Indication Lights" or "Rat Boxes" or "Tattletale Lights" (*17*). Confirmation lights are either visible 360 degrees from any approach or directed towards the position of an officer. Confirmation light is connected to the red phase of the signal and activate simultaneously when the red signal phase is indicated.

The confirmation lights allows one officer to safely observe and pursue red light violators instead of usual the more typical two officers needed without the light. The low cost of confirmation lights ranging from $75 to $150 in 2015 dollars, allowed more installations at intersections of concern thereby reducing enforcement resources.

Boakye evaluated the effectiveness of confirmation lights to reduce RLR on signalized intersections (*4*). Confirmation lights were installed at six left-turn approaches on two signalized intersections considered as treatment sites. RLR violations were also monitored on six spillover sites (intersections nearby to the treatment sites) and five control sites (intersection located far from the treatment sites) in the city of Lawrence, Kansas during morning peak hours (7 a.m. to 9 a.m.) and afternoon peak hours (4 p.m. to 6 p.m.). Violations rates were used as the surrogate to evaluate the confirmation lights which was studied through before, one month after, and three months after installation of the lights. A z-test of proportions was used determine the change in RLR violation rates from the before period to the after periods at the 0.05 level of

significance. Violation time into red was also used as another performance metric to evaluate the confirmation lights. A chi-square Test of Independence was used to determine the violation times into red at the 0.05 level of significance.

From this study it was found that there was 57.4 percent reduction in left-turn RLR violations rates at the treatment sites and 55.7 percent reduction at spillover sites one month after installation of the lights. The three months after study indicated a decrease of 42.7 percent at the treatment sites and a 31.7 percent reduction at the spillover sites. Control sites showed no significant reduction of RLR violations. A chi-square Test of Independence showed no significant effect on the RLR violation times into red.

Lindheimer in 2014 conducted a study to evaluate the long-term effects of the red-signal confirmation lights and factors that led to RLR (*18*). Confirmation lights were installed at two intersections in Overland Park, Kansas, and another 12 signalized intersections were selected as control and spillover sites. A total of 14 intersections were recorded during morning peak hours (7 a.m. to 9 a.m.) and the afternoon peak hours (4 p.m. to 6 p.m.) for a total of 583 hours of traffic video. A test of proportions was used to determine the reduction in RLR violation rates between the before and after studies, also a negative binomial regression model was used to determine the factors affecting the RLR violation. It was found from this study that overall the confirmation lights did not significantly reduce RLR violations, the violation analysis showed that there was a global increase in RLR violations after installation of confirmation lights. The negative binomial model showed that lane volume, presence of a right turn lane, and traffic movement were the significant factors affecting RLR violations.

In 2008 Reddy et al. conducted a before-after study to evaluate the effectiveness of confirmation lights in reducing RLR violations and their associated crashes in Hillsborough County, Florida (*19*). Seventeen intersections were selected and equipped with white enforcement lights and had observers record the day, time and movement of the violations at the study intersections. Violation data were collected on Tuesdays, Wednesdays and Thursdays during the morning and evening peak hours. The crash data for the before and after periods were obtained from the Florida Department of Transportation Crash Analysis Reporting System (CARS) for the year from 2000 to 2005. The results of this study indicated that frequency of crashes was reduced from an average of 40.2 crashes per year before the installation of white lights to 28 crashes per

year after the installation of the white confirmation lights. A matched-pair t-test was performed and it was determined that these results were statistically significant. It was also found that the reduction in violations during the morning peak hour was not statistically significant while the evening violations were at the 0.05 level of significance.

In a study conducted by the University of Minnesota and the City of Burnsville, confirmation lights were installed at two signalized intersections on County Roads 5 and 11 (*20*). The after study analysis revealed that the daily violation rate was reduced by 41 percent. It was also found that the violations increased in heavy traffic and most violations occurred during peak hours.

Although confirmation lights for signalized intersection have been installed in many communities across United States like California, Florida, Kansas, Minnesota, and Texas, no research have been published to determine the effectiveness of the this countermeasure in reducing violations and crash on freeway ramp intersections.

2.4 Literature Review Summary

As reported, RLR continues to be a safety concern for many communities. Researchers have investigated many countermeasures to reduce RLR ranging from high cost to low cost. All these countermeasure have been found to be effective up to a certain level in controlling RLR violation. Low cost counter measure like confirmation lights have been used along with enforcement to reduce RLR violations, and the impact of these countermeasure have been reported in a number of studies. However, no study reporting the effectiveness of confirmation lights on on-ramp intersections was found in the literature review.

The literature reported herein was useful in development of the methodology for this study which is presented in Chapter 4. This research will provide additional information into the effectiveness of the confirmation light for on-ramp signalized intersections.

CHAPTER 3. PROBLEM STATEMENT

The objective of this study was to investigate the effectiveness of a low-cost confirmation lights with targeted enforcement at on-ramp signalized intersection to reduce RLR of the vehicles joining the on-ramp to the freeway. Confirmation lights were chosen as a low-cost option to aid targeted enforcement in reducing RLR violations with the help of one police officer positioned downstream on the ramps. Two ramp intersections in Overland Park, Kansas were selected as the treatment sites to test the effectiveness of this device and five other ramp intersections were selected as the control sites for comparison of data collected.

Following Figure 2 shows the layout of a typical freeway on-ramp intersection with location of confirmation lights and position of officers.

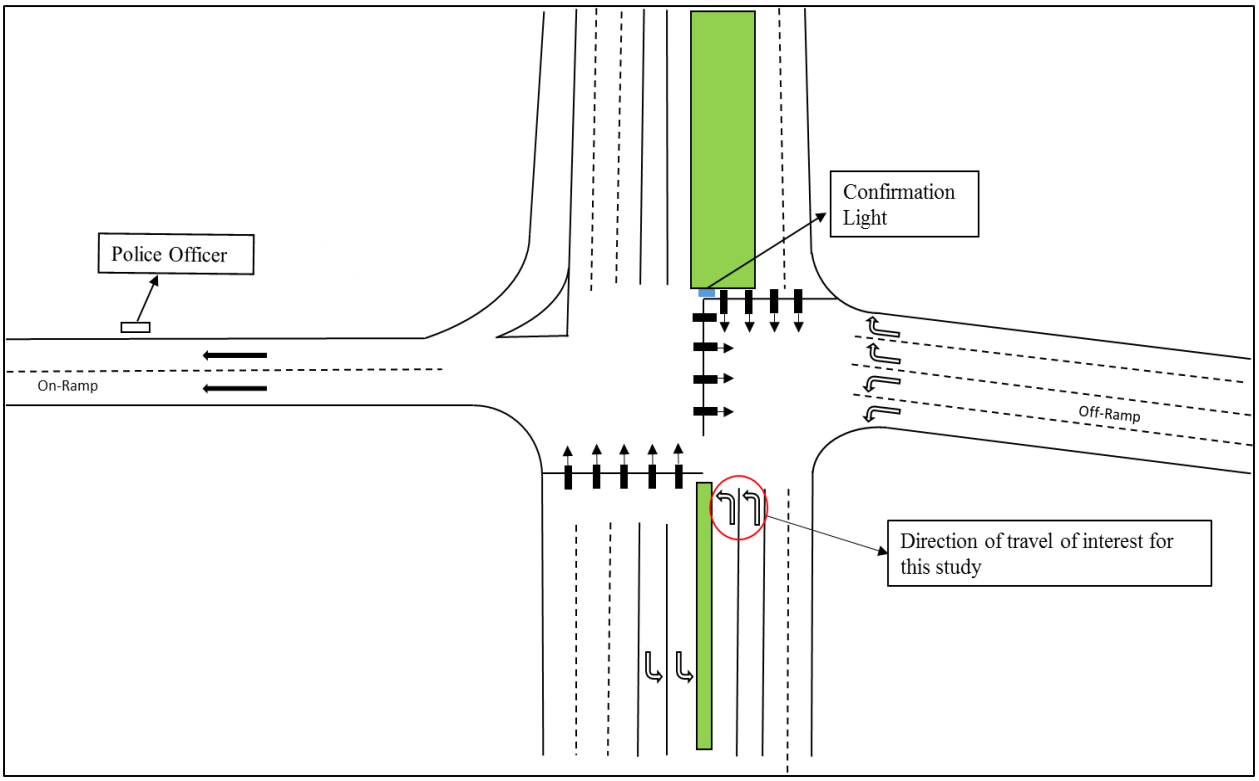


Figure 2. Diagram showing the location of confirmation lights and position of officers

As shown in the Figure 2, an officer will be positioned on the on-ramp looking at the confirmation light on the signal heads to aid in identifying RLR violations. Targeted enforcement was chosen as the necessary countermeasure for the need to apprehend any violators before entering the freeway. In this research confirmation lights cannot affect the driver behavior directly, as the drivers cannot see the confirmation lights. Rather, visible targeted enforcement was used to

influence the driver behavior. Drivers have been found to modify their behavior in direct response to the visible police presence and the possibility of apprehension (*21*).

Change in on-ramp intersection crash data was considered as a study metric, but due to short duration of this research project and insufficient crash data available violation rates were chosen as a surrogate for potential changes in crashes. The primary performance metric used for evaluation of the effectiveness of the confirmation light with targeted enforcement was by a before-after violation study. The violation time into red, which is the indicator of how long after the red signal a vehicle violated the red light, was used as a secondary performance measure for possible crashes.

The before-after violation study was evaluated using two-tailed tests of proportions (z-tests) at the 0.05 level of significance for any positive or negative impacts of confirmation lights on RLR violations. The null hypothesis for this test was, there was no significant difference in the violation rate between the before and each period after installation of the confirmation lights. The alternate hypothesis was that there was a significant difference in the violation rate between the before and one or more of the after study periods. The secondary objective of violation time into red was tested by a chi-square test at the 0.05 level of significance. The null hypothesis for this test was, confirmation lights with targeted enforcement have no effect on violation time into red and the alternate hypothesis was that confirmation lights with targeted enforcement had a significant effect on violation into red for at least one of the periods after the installation.

The following chapter discusses the site selection, method used for collecting video data, the process to reduce the collected data. The results and statistical methods used are presented in detail in Chapter 5.

CHAPTER 4. RESEARCH APPROACH

The research study was conducted in the City of Overland Park, Kansas which has a population of over 178,000 residents. Overland Park is a major commercial center in Johnson County and has a high volume of commuter traffic. The city has a significant number of ramp signalized intersection along the major freeway of I-435 and US 69. Figure 3 shows the city limits of Overland Park with the location of all the freeway ramp intersections. Prior to selecting the study sites, it was specified to the city officials that the study required ramp intersections with similar operations (e.g. Similar traffic signal timing and lane configurations), with no current or planned construction at any on the intersections during the study period.

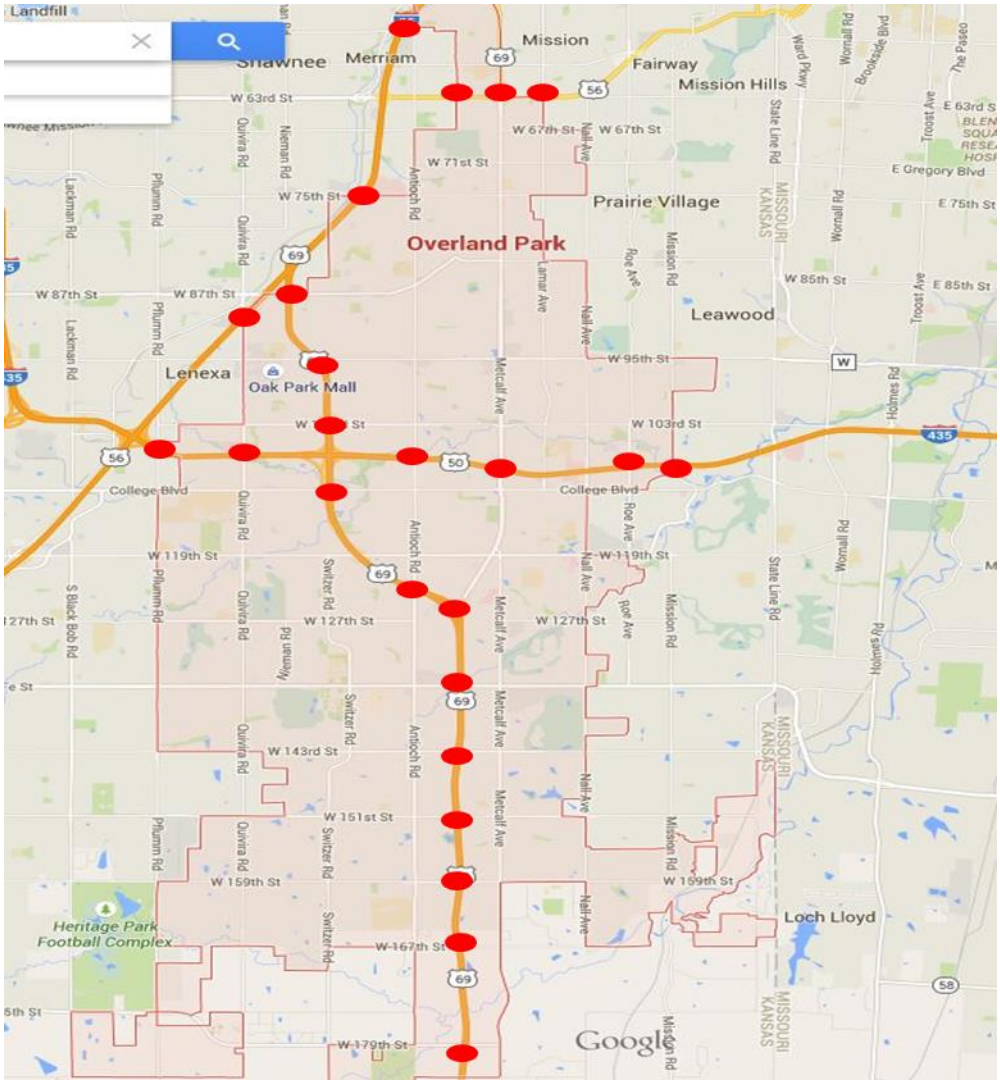


Figure 3. Map of Overland Park with location of freeway intersections (Google maps, 2015)

4.1 Measure of Safety

Crash data are usually used as a measure of safety for the effectiveness of a countermeasure (*22*). In situations where a recent countermeasure is implemented such as in this study, it can be difficult to measure the safety effects of that countermeasure if the crash data for before and after period is limited. However, RLR violations have shown to correlate with RLR crashes previously (*23*). This relationship may not be direct due to the fact that RLR violations occur more frequently than RLR crashes, but a reduction in violations means less exposure and reduced chances for RLR crashes to occur (*25*). In this research study, before-after violation data were used as a surrogate to crash data to evaluate the effectiveness of the confirmation light system with targeted enforcement.

4.2 Site Selection

Prior to meeting with the city officials to seek permission to investigate the confirmation light system, 12 possible intersections were identified for installation of confirmation lights. A set of variables were investigated at each of the intersections including: approach geometry (e.g. number of lanes, ramp elevation, pavement markings), whether an officer on the downstream on-ramp would be able to observe the confirmation light, presence of a safe place on the shoulder of a ramp for a police car to observe the intersection.

12 intersections were reduced to seven candidate sites after meeting with the city officials. This was accomplished by eliminating intersections which did not meet the set of variables explained previously. To verify similarities in traffic volumes at specified intersections, which were deemed to have the most promise for treatment, traffic counts were collected using the non-vehicle detecting overhead camera system installed in Overland Park.

After manual counts were conducted, it was agreed with the City of Overland Park officials (including the city traffic engineer, the city planner, and the police lieutenant in charge of traffic enforcement), that two treatment sites would have the confirmation lights installed. Other intersections were studied as the control sites. A total of two treatment sites and five control sites were selected as appropriate sites for this study.

4.3 Site category

4.3.1 Treatment Sites

As stated previously, two signalized ramp intersections in Overland Park were determined to be optimal locations for the installation of the confirmation lights. These included:

- I-435 and Quivera Road North; and
- I-435 and Quivera Road South.

Both of these intersections are overpass intersections to freeway I-435 which passes through Overland Park. Detailed information on each intersection can be found in the following sections. At the request of the Overland Park officials and the Overland Park Police Department, the research team equipped both of these intersection's protected left turning movement towards on-ramp with confirmation lights

4.3.2 Control Sites

The five control sites selected for the study were the following intersections:

- I-435 and Antioch Road North;
- I-435 and Antioch Road South;
- I-435 and Metcalf Avenue North;
- U-69 and 95th Street East; and
- U-69 and 95th Street West.

The purpose of the control sites was to determine if any global changes were occurring in Overland Park in terms of RLR. For example, if the results indicated a reduction in RLR violations at both treatment and control sites, other factors may have contributed to the reduction of RLR that may or may not have been due to confirmation lights with targeted enforcement. It was expected that a reduction in violation rates at the treatment sites would be an indication of effectiveness of the confirmation lights with targeted enforcement. Figure 4 shows the location of the treatment sites as well as the control sites.

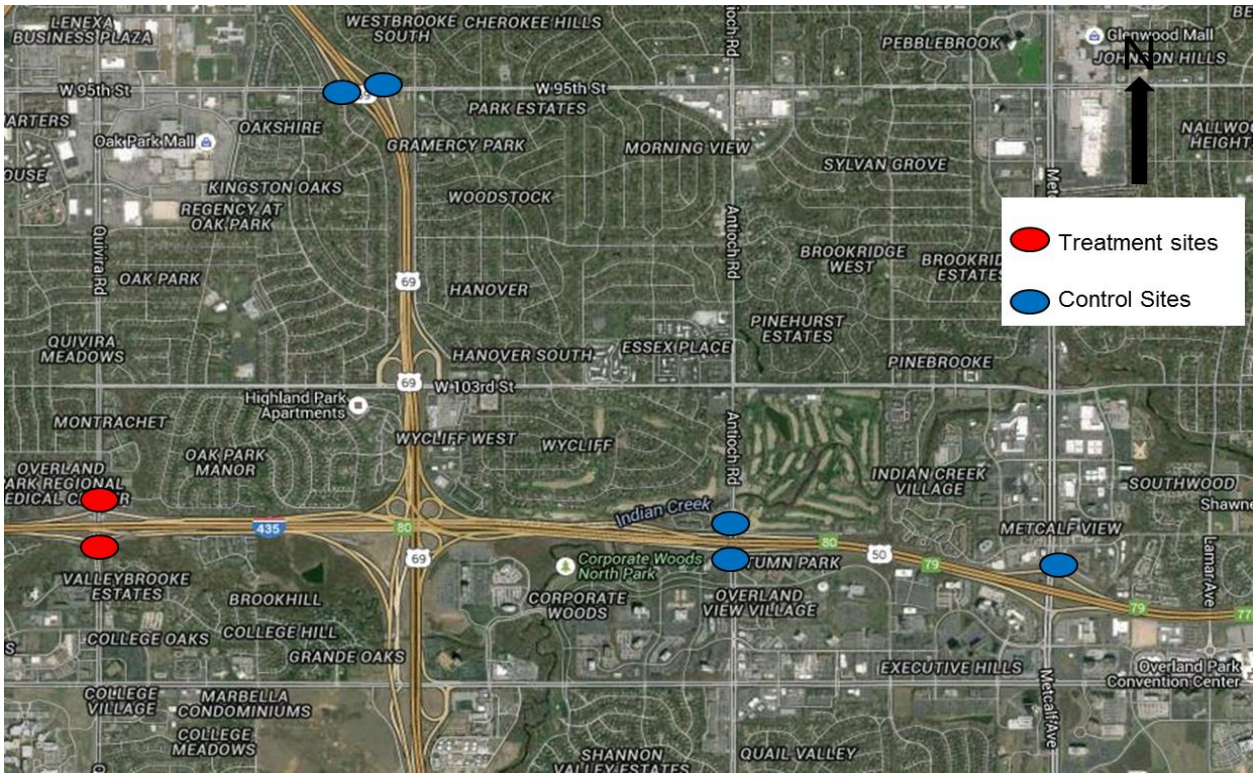


Figure 4. Layout of the treatment and control sites in Overland Park, KS (Google maps, 2015)

4.4 Site Description

As stated in the previous section, seven intersections were used for this study. This section provides additional information for each of the intersections which includes both treatment and control sties. Each intersection is provided with information on posted speed limit, number of left turning lanes and 24 hours volume determined on either a Tuesday, Wednesday, or Thursday.

4.4.1 Treatment Sites

4.4.1.1 I-435 and Quivera Road North

The intersection of I-435 and Quivera Road North is located on the overpass to I-435. This intersection is situated on the west side of the Overland Park City. The Posted speed limit on this intersection is 45 mph and dual protected left turning lanes onto the freeway ramps. 24 hours volume count on this intersection on peak day of the week (i.e. Tuesday, Wednesday, or Thursday) was found to be approximately 4,210 vehicles per day towards on-ramp ramp. The intersection consists of three through lanes and two left turning lanes. Opposing traffic was separated by a two-foot median. No pedestrian activity was recorded at this intersection during the research.

The Kansas City Women's Clinic situated in the northwest corner while the Overland Park Surgery Center was in the northeast corner of the intersection. These two commercial centers were major contributors to the traffic at this intersection.

4.4.1.2 I-435 and Quivera Road South

Similar to I-435 and Quivera Road North, the second confirmation light was installed on the left turning on-ramp movements from I-435 and Quivera Road South. This intersection is situated at about 600 feet from the first treatment site. The posted speed limit on this corridor is 45 mph. 24 hours volume counts on this intersection on a peak day of the week (i.e. either Tuesday, Wednesday, or Thursday) was found to be approximately 5,700 vehicles per day towards on-ramp. The intersection consisted of three through lanes and two left turning lanes onto I-435. Residential areas are located on the southwest and southeast quadrants of this intersection.

4.4.2 Control Sites

4.4.2.1 I-435 and Antioch Road North

The intersection of I-435 and Antioch Road North is located east of the treatment sites on the I-435 corridor. The posted speed limit on this intersection is 45 mph and served approximately 4,200 vehicles per day towards on-ramp. Figure 5 shows the aerial view of the intersection.

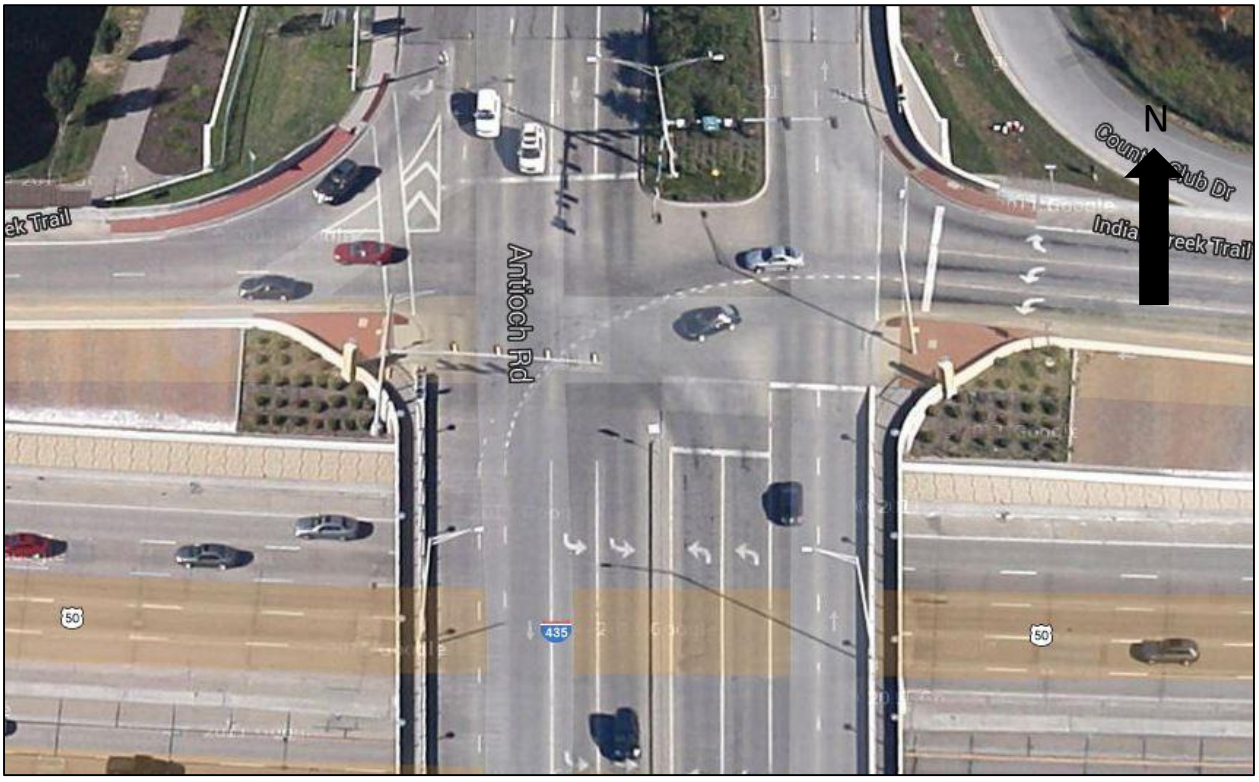


Figure 5. Aerial view of the intersection of I-435 and Antioch Road North (Google maps, 2015)

As shown in Figure 5, the intersection consisted of two through lanes and two left turning lanes. A golf course and residential complex are located on the northeast and northwest quadrants of this intersection, respectively. Figure 6 shows the ground view of the intersection.

Figure 6. Ground view of the intersection of I-435 and Antioch North (Google maps, 2015)

Shown in Figure 6 is a ground view of the intersection looking northbound. All left turn approaches were protected signal heads. The left turn approaches are fully actuated coordinated.

4.4.2.2 I-435 and Antioch Road South

This intersection was located approximately 300 feet south of the first control site. The posted speed limit is 45 mph and had an approximate 24 hour volume as 5,800 vehicles per day towards on-ramp. Following Figure 7 shows the aerial view of the I-435 and Antioch Road South.

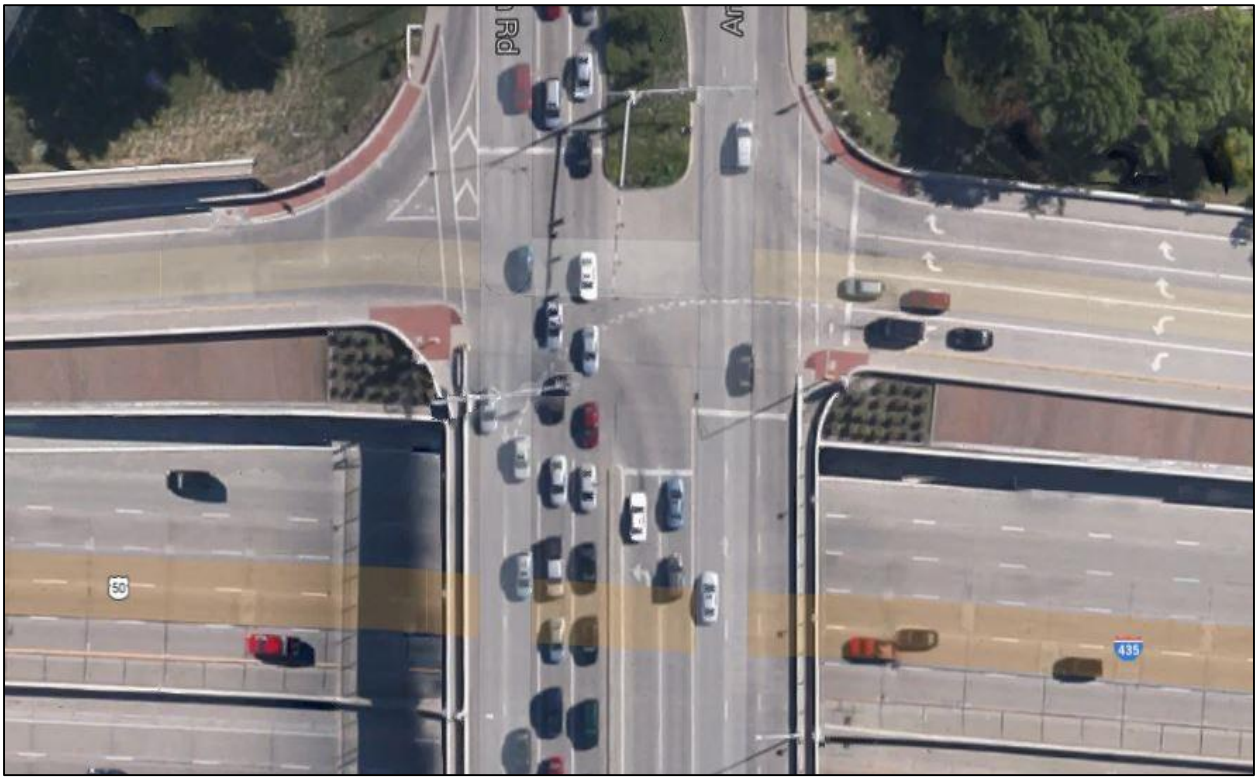


Figure 7. Aerial view of the intersection I-435 and Antioch Road Southbound (Google maps, 2015)

As shown by the aerial image in Figure 7, the intersection consists of three through lanes and two left turning lanes. A commercial complex and residential complex are located in the southwest and southeast quadrants of the intersection, respectively.

Figure 8. Ground view of the intersection of I-435 and Antioch Road Southbound (Google maps, 2015)

Shown in Figure 8 is a ground view of the intersection looking southbound. All left turn approaches were provided protected-only movements. Left turn approaches are fully actuated signals for most part of the day. This intersection served higher volumes during the evening peak hours.

4.4.2.3 I-435 and Metcalf Avenue North

This intersection handles the highest traffic volume among all selected intersections for the research, located east of the treatment sites. This was the only intersection in the research study which was an underpass to I-435 and made an ideal location for positioning a downstream officer at the on-ramp to observe for RLR. The intersection of Metcalf Avenue was originally the top candidate for treatment site. However, due to non-availability of an overhead camera, this intersection was rejected as a treatment site. The posted speed limit on this intersection is 45 mph and served an approximate 24 hours volume of 7,800 vehicles per day towards on-ramps.

Figure 9. Aerial view of the intersection of I-435 and Metcalf Avenue North (Google maps, 2015)

As shown in Figure 9, the intersection was comprised of three through lanes and two left turning lanes. A hotel and commercial complex were situated on the northeast and northwest quadrants of the intersection, respectively. Figure 10 shows the ground view of the intersection of I-435 and Metcalf Avenue North.

Figure 10. Ground view of the intersection of I-435 and Metcalf Avenue North (Google maps, 2015)

Shown in Figure 10 is a ground view of the intersection looking northbound. All left turn approaches were protected signals. Left turn approaches are fully actuated. Most the traffic consisted of commercial and commuter passenger cars.

4.4.2.4 US-69 and 95th Street East

The intersection of US-69 and 95th street is located north of the selected treatment sites. The posted speed limit at this intersection is 35 mph. The approximate 24 hour volume for peak day was about 3,000 vehicles per day towards on-ramp. Figure 11 shows the ground view of the intersection of US 69 and 95th Street East

Figure 11. Ground view of intersection of US-69 and 95th Street (Google maps, 2015)

As shown in the Figure 11, the intersection consisted of two through lanes and one channelized left turning lane. This intersection is surrounded by residential areas. The left turning lane was a protected-only left turn lane.

4.4.2.5 US-69 and 95th Street West

This intersection was a selected as second control site in the 95th Street corridor. The posted speed limit is 35 mph and the approximate 24-hour volume on a peak day was found to be 1,800 vehicles per day towards on-ramps.

Figure 12. Ground view of intersection of US-69 and 95th Street West (Google maps, 2015)

Figure 12 shows that the intersection consisted of two through lanes and one channelized left turning lane. Residential areas were located on northwest and southwest quadrants of this intersection.

4.5 Field Data Collection

A before-after RLR violation study was conducted to determine the effectiveness of confirmation lights in conjunction with targeted enforcement in Overland Park, KS. The most effective method to obtain and reduce data was using the video data at left turning approach towards the freeway ramps. However, due to the location of the study sites and the duration of data needed, capturing and reducing traffic video data using video camera can be complicated and time consuming. Overland Park was consulted about using their installed overhead cameras located at all of the study intersections. Figure 13 shows an example of the view of the overhead video provided by the camera at I-435 & Antioch Road North.

Figure 13. Overhead camera view of an intersection northbound approach

Figure 13 shows a view of an intersection in which a single approach could be monitored. As stated in the previous section, all the intersections under investigation were monitored only for left turning movements towards the on-ramps. The field view was needed to view the approach stop line and current phase of the signal. As shown in Figure 13, the recorded field of view by the overhead camera showed the stop line, and the vehicles. All of this was used to determine the number of violations and time into red (seconds).

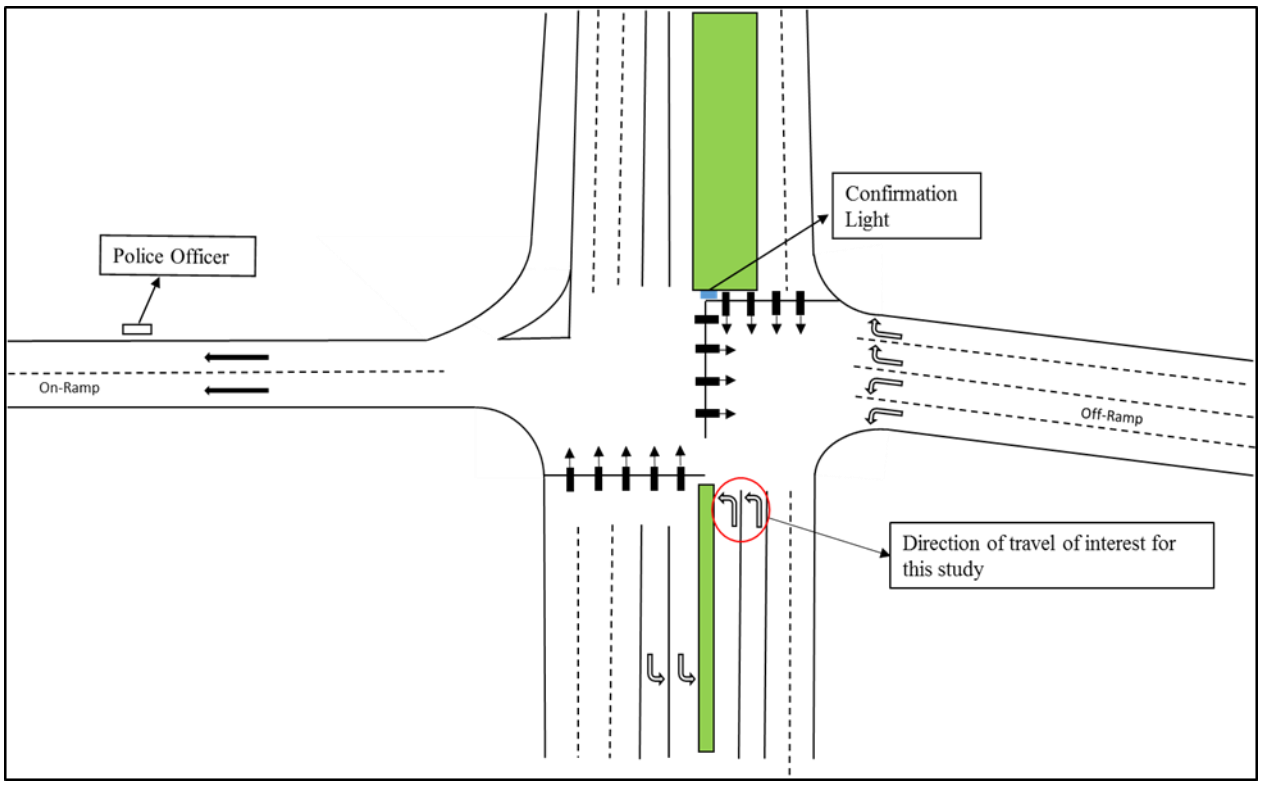


Figure 14. Layout of targeted enforcement with confirmation light at typical dual left on-ramp signalized intersection

Figure 14 shows the layout of the enforcement strategy with confirmation lights at a typical dual-left on-ramp signalized intersection. The confirmation lights shown in the Figure 14 were installed only on left turning signal heads. These lights were visible only to the officer stationed on the ramp. The Confirmation lights would activate as soon as the left turning signal showed red. Any RLR violators could then be apprehended by the officer present on the ramp before entering into the freeway.

Video data were collected on Tuesdays, Wednesdays and Thursdays that were non-holiday. Data were collected 24 hours at a time to encompass violations occurring during different lighting and traffic conditions. Same data collection methodology was used for the after study. The dates in which video were collected including the installation date are as follows:

- Before Study – August 26 to August 28, 2014;
- Confirmation Light Installation – September 10, 2014 (No data were collected) ;
- One Month After Study – October 14 to October 16, 2014; and
- Three Months After Study – December 16 to December 18, 2014.

4.6 Data Reduction

A total of 1,512 hours of video data were collected for the entire project. Intersection video data were reduced manually. A methodology was developed to ensure accurate video data reduction. The following guidelines were followed to reduce the video data:

- A vehicle that proceeded through (or crossed the stop line) made a left turn after the onset of the red signal was considered a RLR violation.
- A vehicle that crossed the stop line during the yellow interval, or was in the intersection during the onset of the red interval was not considered a RLR violation.
- If a vehicle ran a red light, the time into red was determined and recorded by calculating the time it took the vehicle to enter the intersection after the onset of red.
- If a vehicle ran a red light, the type of vehicle was recorded by its respective code as shown in Figure 15 (e.g. motorcycle (1), passenger car (2), etc).
- While monitoring the intersection, traffic counts for different time periods were recorded (e.g. morning peak hours, evening peak hours, and night time).
- Violations were recorded based on the configurations shown in Figure 16. Table 2 explains the configurations indicated by codes (0 through 4).

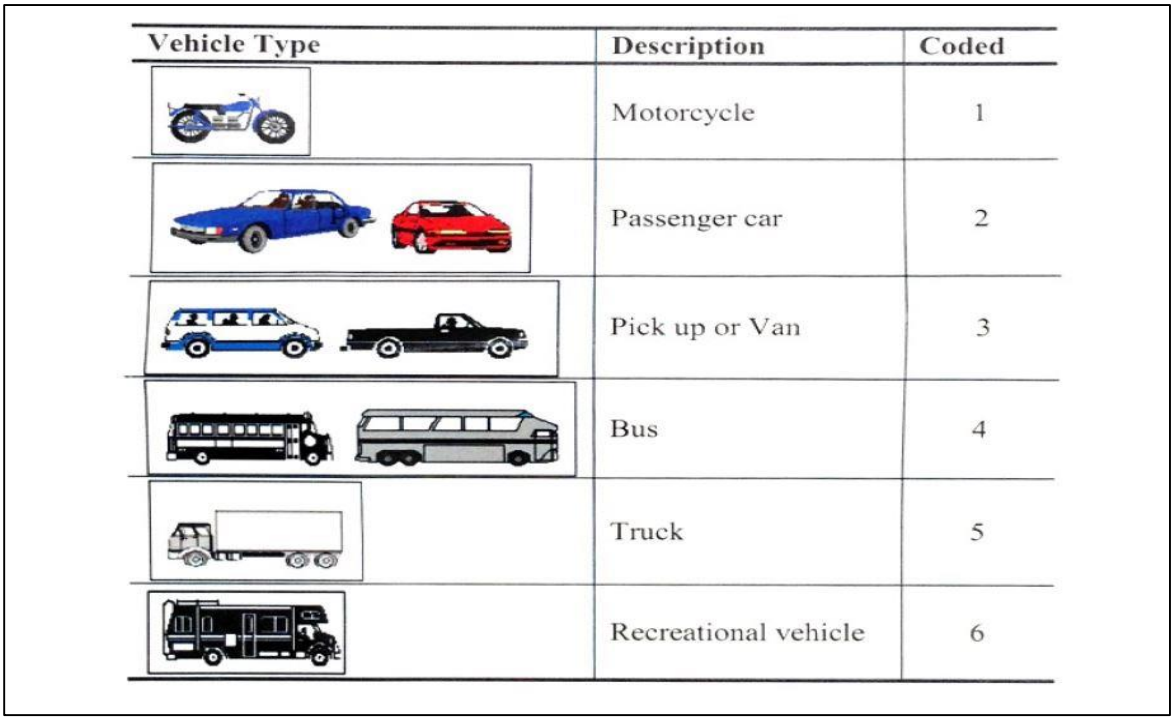


Figure 15. Vehicle categories for data reduction (*4*)

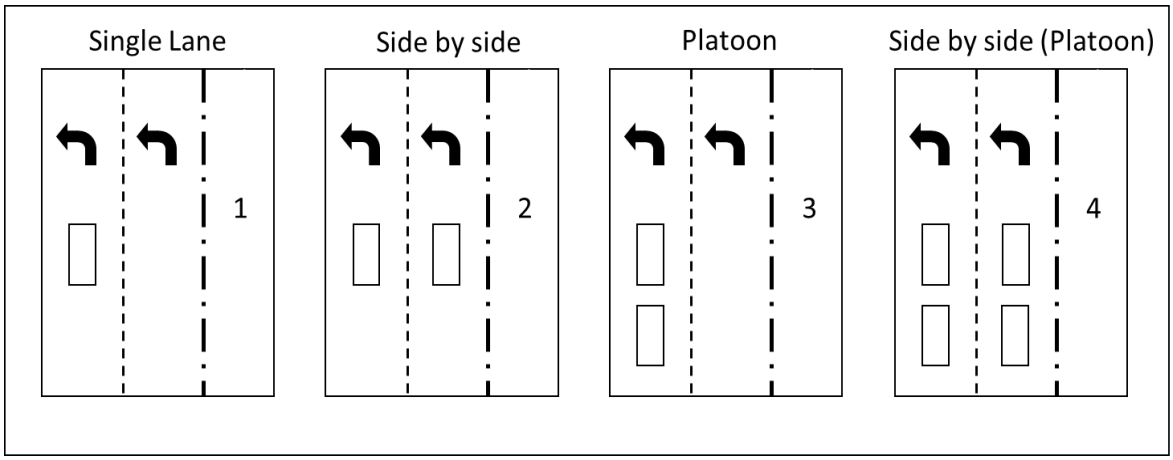
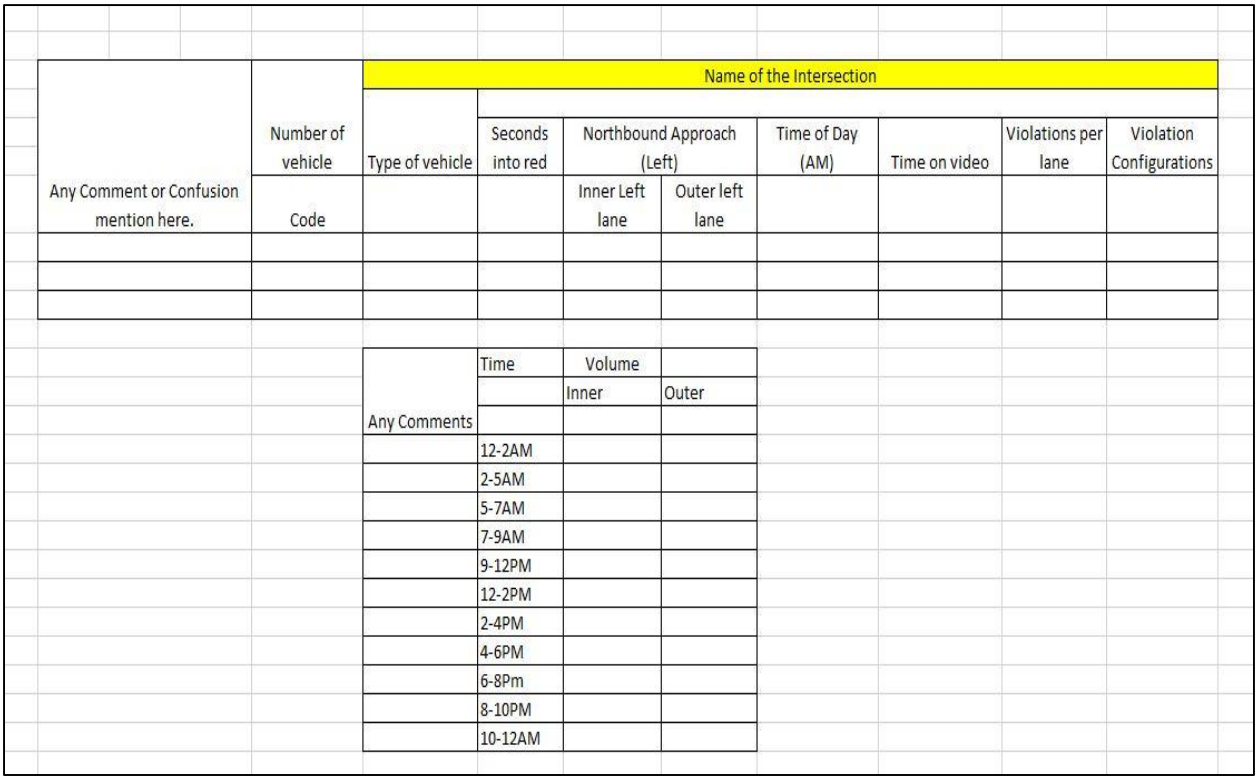


Figure 16. Left turn RLR violation configuration

Table 2. RLR Violation Configuration Description

Code	Violation Description
1	A single vehicle violates the red light on a left turn lane.
2	Two vehicles (travelling side by side) violate the red light on dual left turn lanes.
3	Two or more vehicles in a platoon violate the red light on a left turn lane.
4	Three or more vehicles in a platoon and travelling side by side violate the red light on dual left turn lanes.

Illustrated in Figure 17 is the template that was used to reduce the video data.



Any Comment or Confusion mention here.	Number of vehicle	Name of the Intersection							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (AM)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				

Any Comments	Time	Volume	
		Inner	Outer
	12-2AM		
	2-5AM		
	5-7AM		
	7-9AM		
	9-12PM		
	12-2PM		
	2-4PM		
	4-6PM		
	6-8Pm		
	8-10PM		
	10-12AM		

Figure 17. Template used for reduction of data

The primary data of interest shown in Figure 17 are the number of vehicles that ran the red light, type of vehicle, seconds into red, on which lane the violation occurred, the type of configuration, and the time of day the violation occurred. Additionally, the traffic counts for the entire 24 hours were recorded during the different times of day. Detailed results for all the study intersections are shown in Appendix A.

Once reduction of the intersection was completed by a student worker, the sheet was submitted to the researcher to perform a quality check on the data. Any recorded incident as a violation was reviewed to ensure a RLR violation occurred and was recorded accurately. Student workers were also encouraged to note down any unusual activities or incidents taking place during the reduction of data. Once the data reduction effort was complete, the data were aggregated into a single spreadsheet for analysis.

4.7 Installation of Confirmation Lights

McCains enforcer lights, which cost approximately $135 per light. The confirmation light came in multiple colors including blue, red, white, or amber. It also came with standard Light Emitting Diode (LED) mounted on a circuit board weighing one pound in a black 6061-T1 aluminum casing. The confirmation light comes with a two strand wire with an option of a ground wire. Other specifications about the confirmation lights used are provided in the Appendix B.

Figure 18. Confirmation light before installation

Figure 18, shows the confirmation light as provided by the manufacturer. A standard two-wire light was ordered without the ground wire after consulting with the Overland Park traffic technicians.

Figure 19. Confirmation light installed on left turning movement traffic signal

The Figure 19 shows a working of a confirmation light installed on the left turning traffic signal at the intersection of I-435 and Quivera Road North in Overland Park, Kansas. The photo was taken where an officer in a patrol car would observe the light from the on-ramp. The confirmation lights were installed on the left turn signal at both intersections (I-435 & Quivera Road North and I-435 & Quivera Road South) on September 10, 2014.

4.8 Data Collection and Reduction Limitations

Collecting field data can result in unknown and sometimes complicating situations. Some of the challenges which complicated the data collection and reduction efforts include the following:

- Stop lines were not visible on 18th December, 2014 at 12 a.m. to 3 a.m. on all intersections due to heavy snow. The data observed during this period was not included in the research.
- Camera angles were changed by the city of Overland Park during multiple instances due to issues on I-435 or on the surrounding streets. No data were recorded during these periods. Camera angle were changed at following locations and times shown in Table 3.

Table 3. Location and Time of Camera Angle Changes

Location	Date	Time
I-435 and Quivera North	October 14, 2014	12 a.m. to 6 a.m.
I-435 and Quivera South	August 28, 2014	8 a.m. to 9 a.m.
		4 p.m. to 5:20 p.m.
	October 15, 2014	8 a.m. to 2 p.m.
		4:40 p.m. to 6 p.m.
	December 17, 2014	2 p.m. to 6 p.m.
	December 18, 2014	2 p.m. to 6 p.m.
I-435 and Antioch North	August 26, 2014	2 a.m. to 6:20 a.m.
	October 14, 2014	5 a.m. to 6 a.m.
		8 p.m. to 12 a.m.
	October 15,2014	12 a.m. to 6 a.m.
	October 16, 2014	12 a.m. to 5 a.m.
	December 16 , 2014	8 p.m. to 12 a.m.
	December 17, 2014	12 a.m. to 6 a.m.
		5:15 p.m. to 6 p.m.
I-435 and Antioch South	August 26, 2014	2 a.m. to 6:20 a.m.
	August 28, 2014	12:20 p.m. to 2 p.m.
	December 18, 2014	12 a.m. to 6 a.m.
I-435 and Metcalf Avenue North	August 27, 2014	12:25 a.m. to 6 a.m.
		3:30 p.m. to 12 a.m.
	August 27, 2014	11 a.m. to 5 a.m.
	October 14, 2014	12 a.m. to 9:45 a.m.
	October 15, 2014	5:30 p.m. to 6 p.m.
	December 18, 2014	12:30 a.m. to 6 a.m.
US-69 and 95th Street East	October 15, 2014	1:20 p.m. to 6 p.m.
	December 18, 2014	9 a.m. to 12 a.m.
US-69 and 95th Street West	August 26, 2014	4:40 a.m. to 6 a.m.

CHAPTER 5. ANALYSIS

This chapter presents the descriptive statistics of all before and after RLR violation data collected at the seven study intersections. Variables including: RLR violations rates by intersection left-turning lane, time of the day when RLR violations occurred, time into red, the vehicle types involved in RLR violations, and the RLR violations by configuration type, are presented in this chapter.

5.1 RLR Violation rates by Left-turning Intersection Lane

5.1.1 Methodology

Violation data were reduced as described in Chapter 4. RLR violations were expressed as a rate of violations per 10,000 entering vehicles (TEV) by using Equation 1. A violation rate was used in order to take into account varying intersection traffic volumes.

$$\boldsymbol{Rate(TEV) = \frac{N_i}{V_i} \times 10,000\ Entering\ Vehicle} \quad \textbf{Eq. 1}$$

Where: N_i = total number of violations (N) observed during the study period *i;* and

V_i = total number of entering vehicles (V) during the study period *i.*

5.1.2 Results

Figure 20 shows the left-turn RLR violation rates for the two types of study sites during the entire 24 hours of peak days of the week for the before study, the one month after study, and the three month after study. Both the study sites showed reductions in violation rates for the one month and the three month after study compared to violation rate before installation of the confirmation lights.

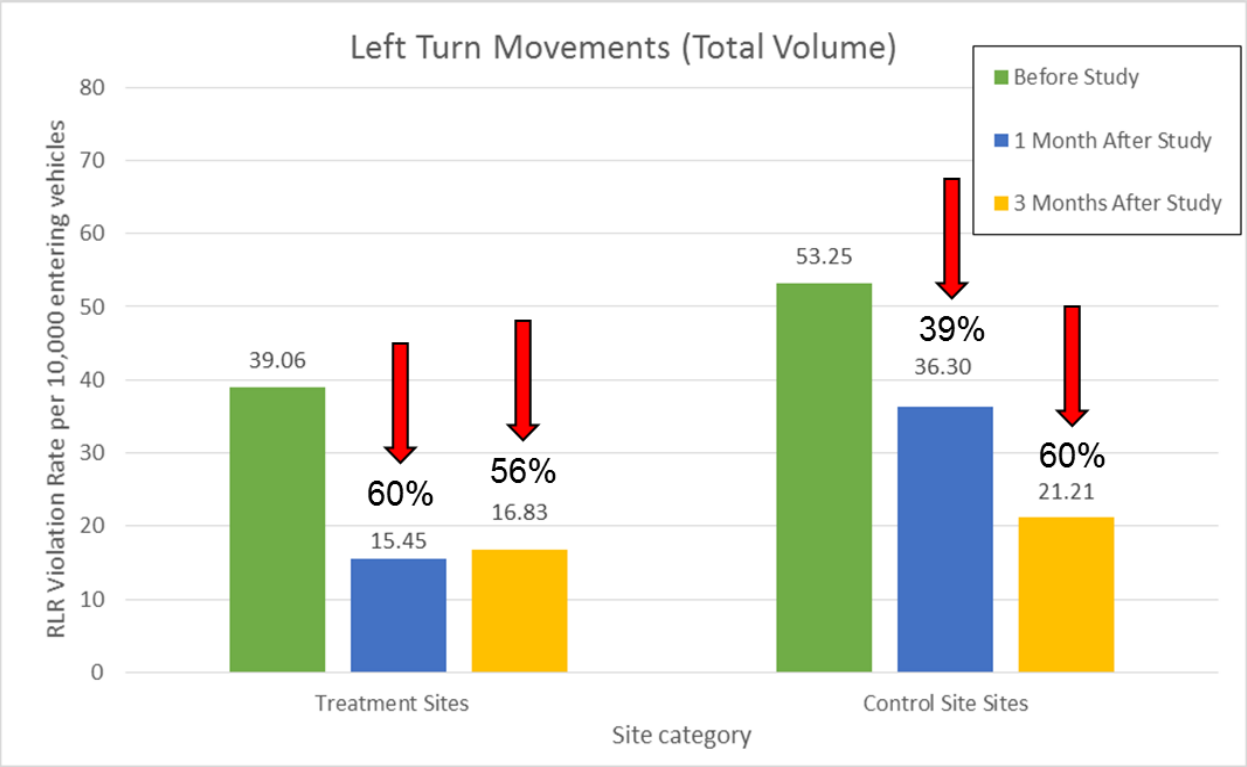


Figure 20.Total left-turn RLR violations rates per study intersection for the before-after study

From Figure 20, the treatment sites experienced a reduction in RLR violation rates after the installation of the confirmation lights. There was a reduction of 60 percent between the period before installation and the period one month after installation and 56 percent reduction between the before period and the period three months after installation.

The control sites revealed a reduction in violation rates after installation of confirmation lights through the entire study period. There was a reduction of 39 percent between the period before installation and the period one month after installation and 60 percent reduction between the before period and the period three months after installation.

5.2 RLR Violation Rates by Time of the Day

Studies have shown that a majority of RLR occurs during normal work hours (*24*). During morning and evening peak hours, drivers possibly tend to run a red light due to being late for work and also by frustration at being stuck in traffic. However, the frequency of RLR violation is influenced by the time of the day. One of the recommendation made in the studies by Lindheimer (18) and Boakye

(**Error! Bookmark not defined.**) were about recording data for RLR violation during off-peak ours. Thus part of this study, investigation of the distribution of the RLR violations by time of the day was carried out to determine if RLR violations were impacted by the time of day as well. Figures 21 and 22 display the results of the distribution of violations at the morning peak (7:00 a.m. to 9:00 a.m.), afternoon peak (12:00 p.m. to 2:00 p.m.), evening peak (4:00 p.m. to 6:00 p.m.), and night (8:00 p.m. to 10:00 p.m.).

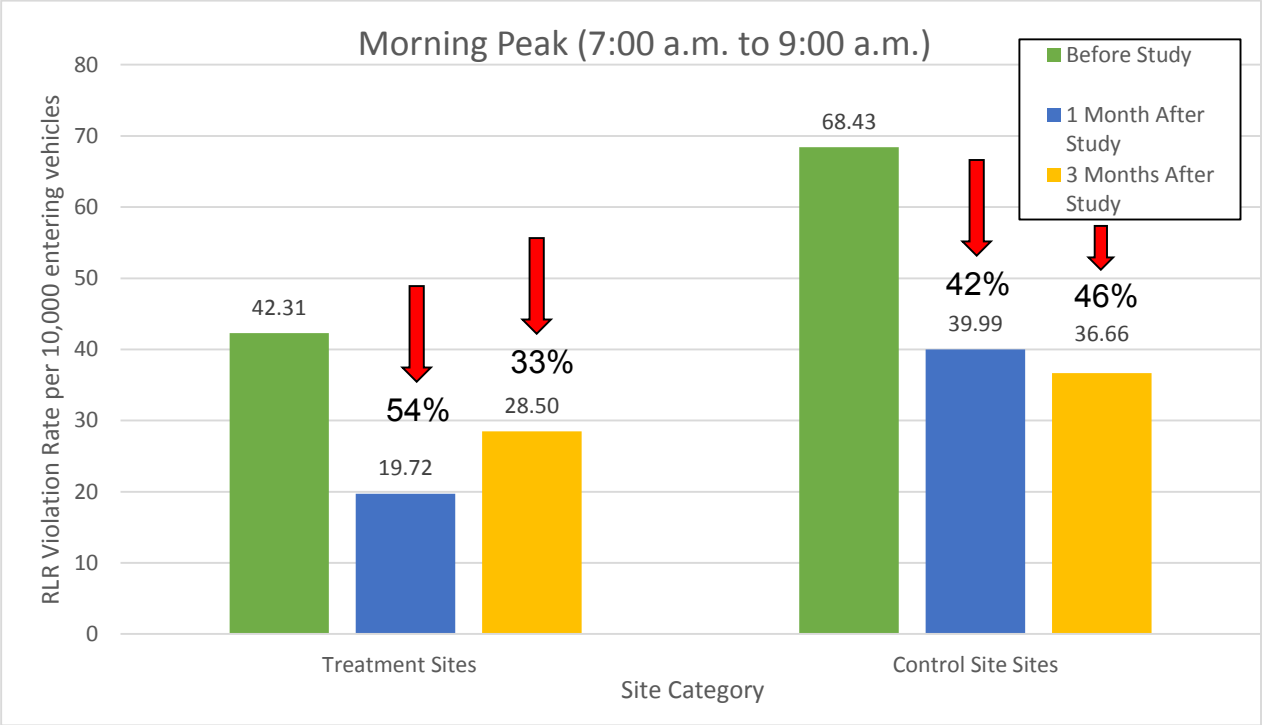


Figure 21. Morning peak left-turn RLR violations per study intersection for the before-after periods

Figure 21 illustrates the distribution of RLR violation rates for morning peak hours for the left turn movement on-ramp. For the treatment sites there was a reduction of 54 percent between the period before installation and the period one month after installation and 33 percent reduction between the before period and the period three months after installation. The overall trend shown in this figure was consistent with the expectation of reduced RLR violation for after studies compared to before studies. Figure 21, for treatment sites, the reduction in RLR violation rate increased for three month after installation period when compared to one month study period. Compared to total RLR violation rate in Figure 20, a higher violation rate can be observed in the morning peak, which shows that most RLR occurs times when drivers are commuting to work.

The frequency of the distribution of RLR violation rates for the mid-day hours is shown in Figure 22 for left-turning movement on-ramps from 12 p.m. to 2 p.m.

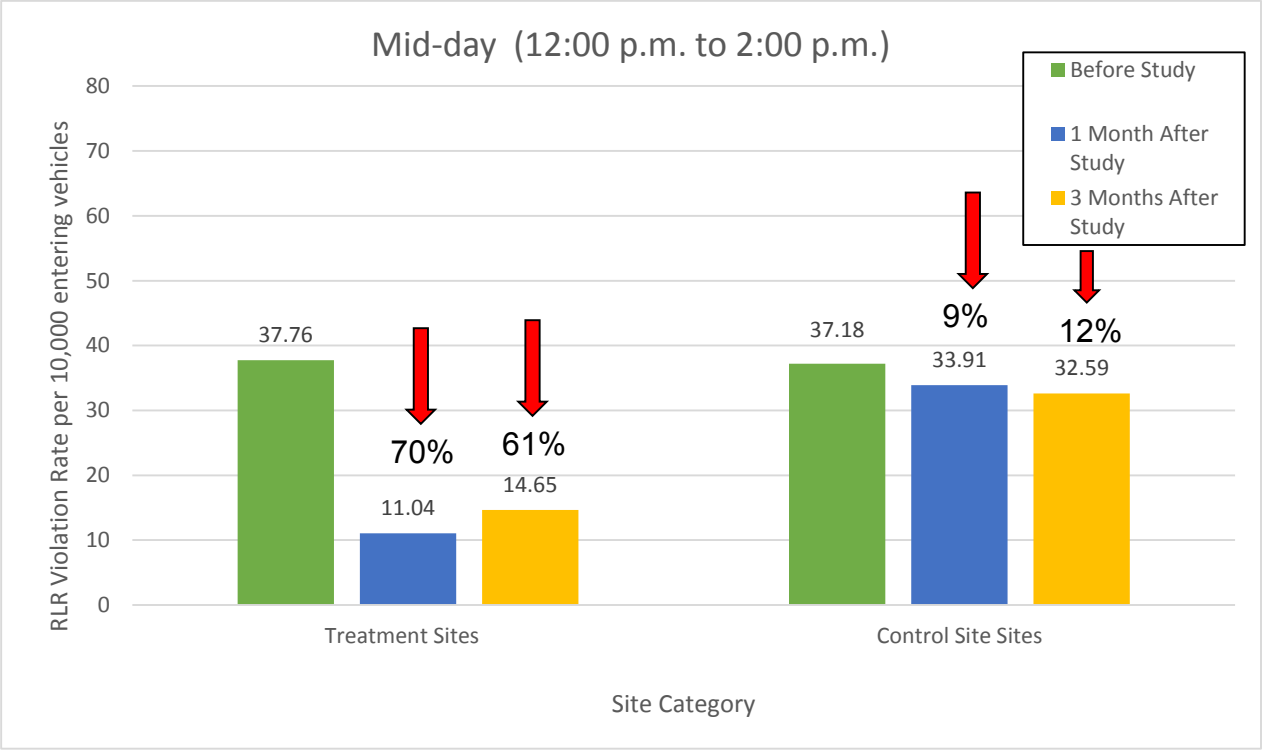


Figure 22. Mid-day left-turn RLR violations per study intersection for the before-after periods

A high violation rate was observed before installation of the confirmation lights on the treatment site and approximately similar results were revealed on the control sites. One month after studies showed a reduction in RLR violation rates for the treatment and control sites. For the treatment sites there was a reduction of 70.8 percent between the period before installation and the period one month after installation and 61.2 percent reduction between the before period and the period three months after installation.

Control sites showed reduction in RLR violation rates. There was a reduction of 9 percent between the period before installation and the period one month after installation and 12 percent reduction between the before period and the period three months after installation.

Figure 23 illustrates the RLR violation rates for the evening peak hours from 4 p.m. to 6 p.m. for left-turning movement at on-ramps

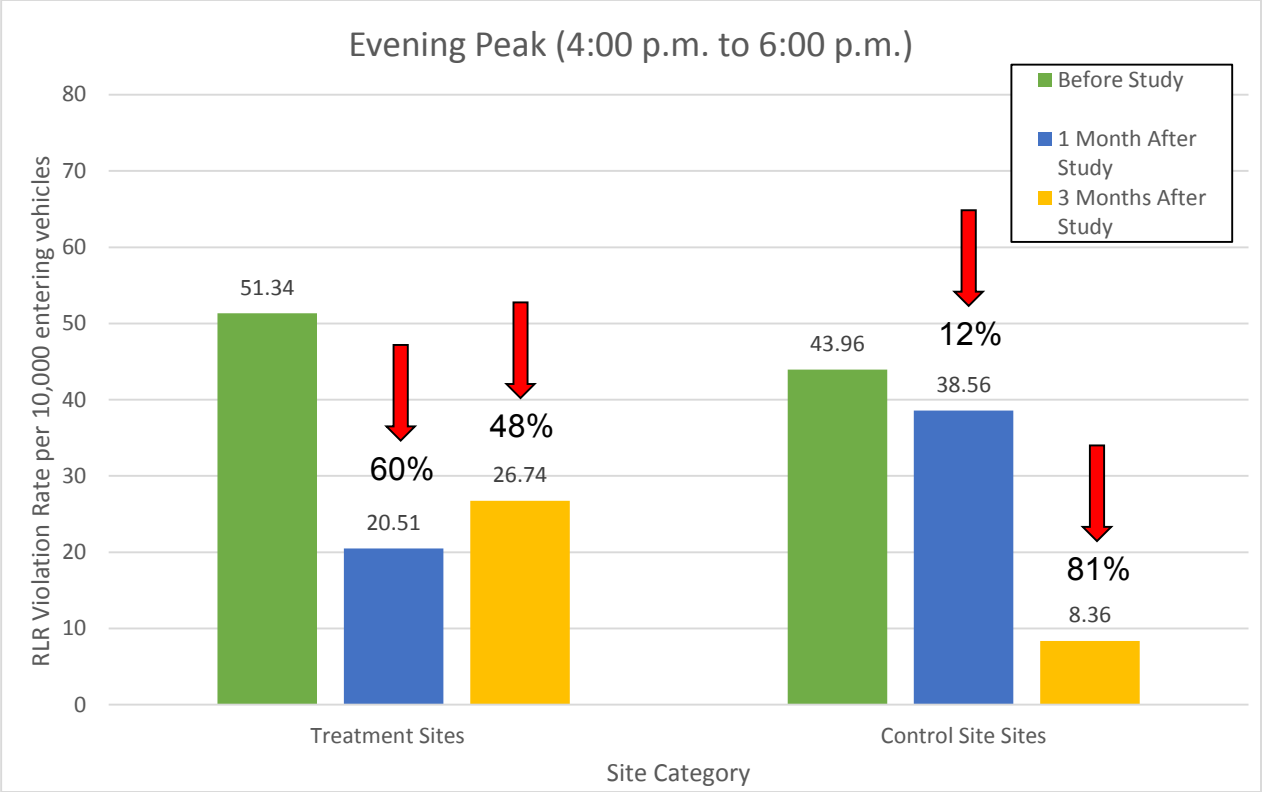


Figure 23.Evening peak left-turn RLR violations per study intersection for the before-after periods

As shown, the evening peak hour show the highest RLR violation rate for the entire day at both treatment and control sites. The expected trend continues for the evening peak hour where at treatment site, the reduction in violation rate is observed only for one month after study and a slight increase in RLR violation rate for three months after study, overall however the RLR violation is reduced compared to before study. At the control sites, the reduction in RLR violation rates continues from the before study until the three month after study.

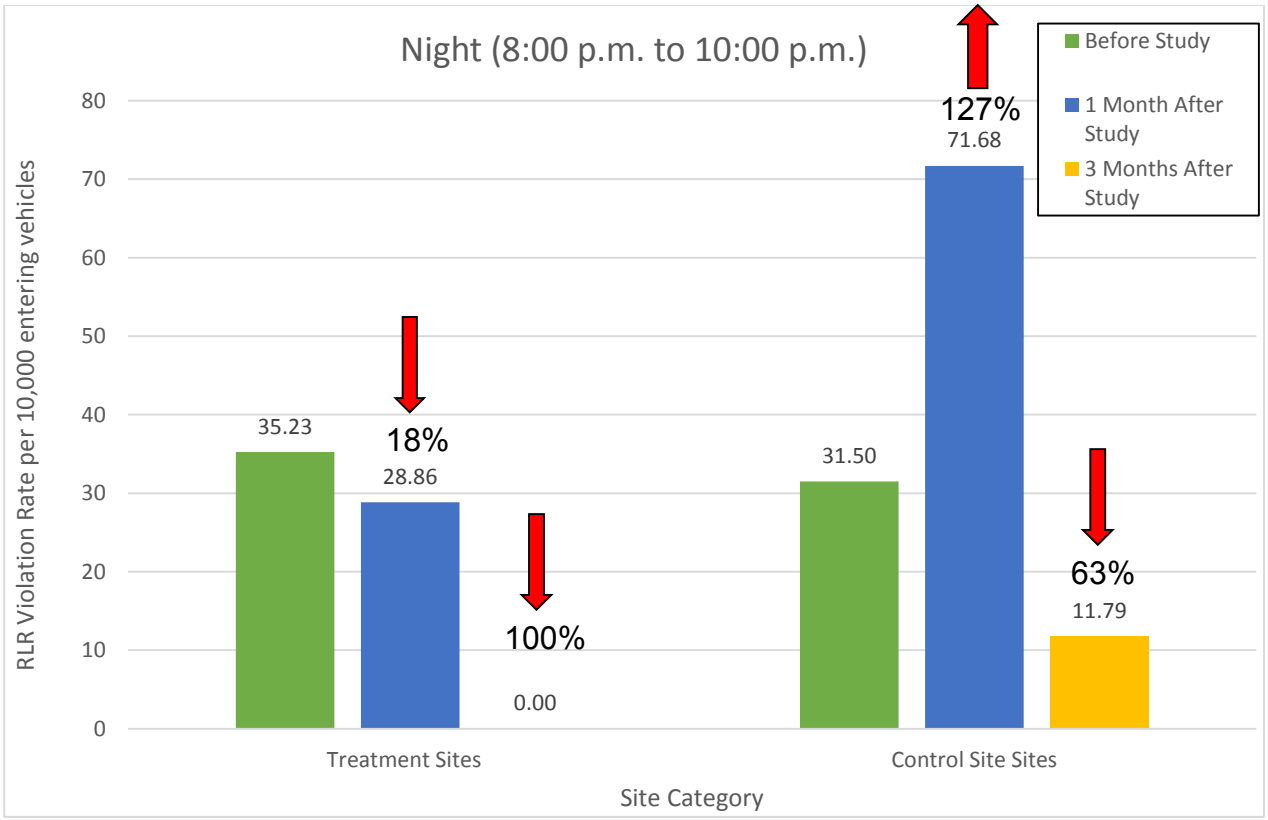


Figure 24. Night time left-turn RLR violations per study intersection for before-after periods

Figure 24, shows the RLR violation rates for the night time periods from 8 p.m. to 10 p.m. Violation rates during this time were observed mainly to investigate the drivers' behavior towards left-turning signal on-ramps during low volume periods. For the treatment sites 18 percent reduction was observed for one month study period and 100 percent reduction in violation were recorded for three month study period. For the control sites, the RLR violation rate increased 127 percent compared to the before installation period but was reduced by 62.5 percent for three month period.

5.3 Time into Red Analysis

5.3.1 Background

How long into the red cycle a violation occurs is an important aspect of vehicles running a red light. Violations found within the all-red interval (generally one to two seconds) are most likely due to a driver either caught in the indecision zone or followed a platoon through a signalized intersection. The indecision zone is an area before the stop line, within which driver is unsure either to stop or proceed through an intersection during the yellow phase of the signal. However, drivers that enter

the intersection past the all-red phase increase the likelihood of conflict with the cross traffic that has the green light. The effectiveness of confirmation lights in this study was evaluated by determining if the change in time into red for violations captured by the video data could be observed.

5.3.2 Methodology

Time into red was evaluated by comparing treatment sites to controls sites for the three study periods (before, one month after installation, and three months after installation). Time into red was plotted where the y-axis was the number of violations and the x-axis was time into red (in seconds) as shown in Figure 25 and 26. It should be noted, unlike the previous section, the number of violations was plotted for time into red instead of the RLR violation rate.

5.3.3 Results

Figures 25 and 26 shows the result of the RLR time into red for the total volume left-turning movement on-ramp for treatment and control site. As shown in Figure 25, most of the violations at the treatment site occurred between one seconds and three seconds after the onset of red light. The total number of violations that occurred is reduced after the confirmation lights were installed. It was found that 19 percent of RLR violations occurred after five seconds, increasing the chances of crash with the conflicting movement. A 29.5 percent and 41.2 percent reduction in number of violation after five seconds were observed after the installation of light for one month and three month study periods respectively.

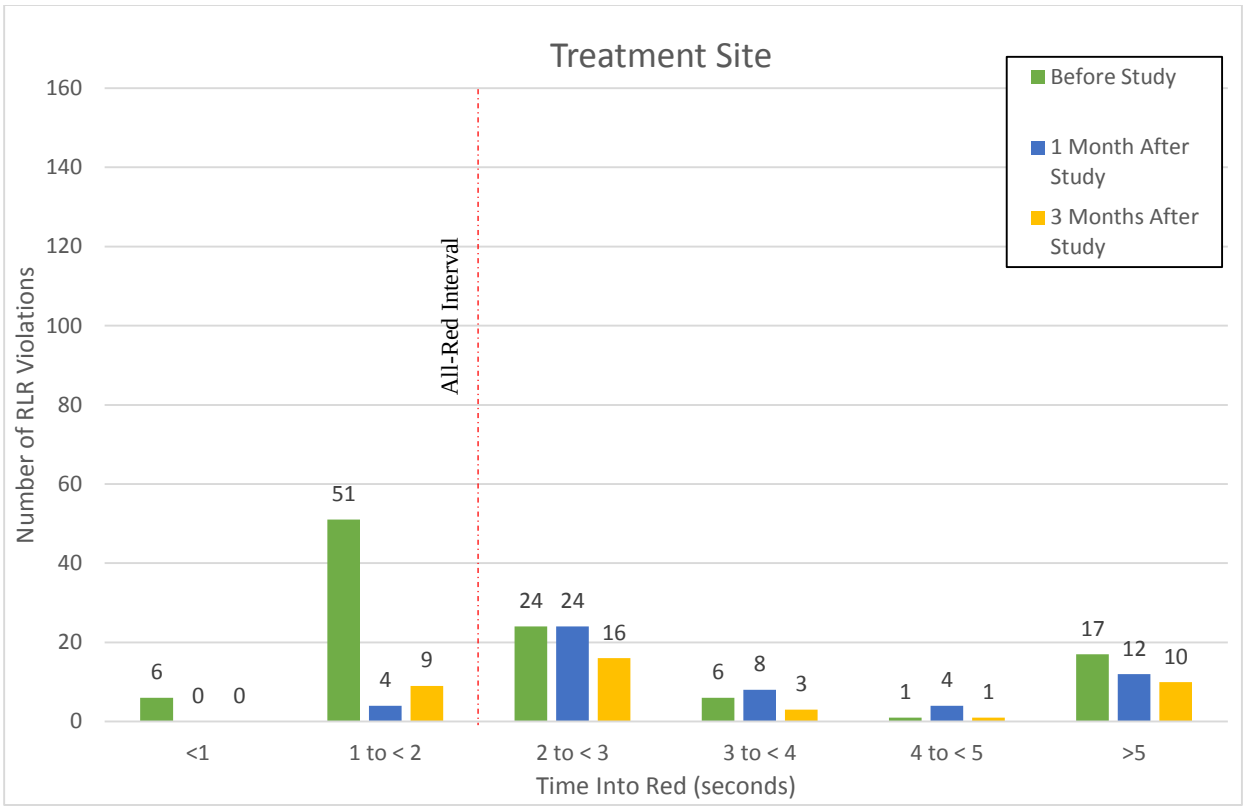


Figure 25. Time into red for the total RLR violations at the treatment sites

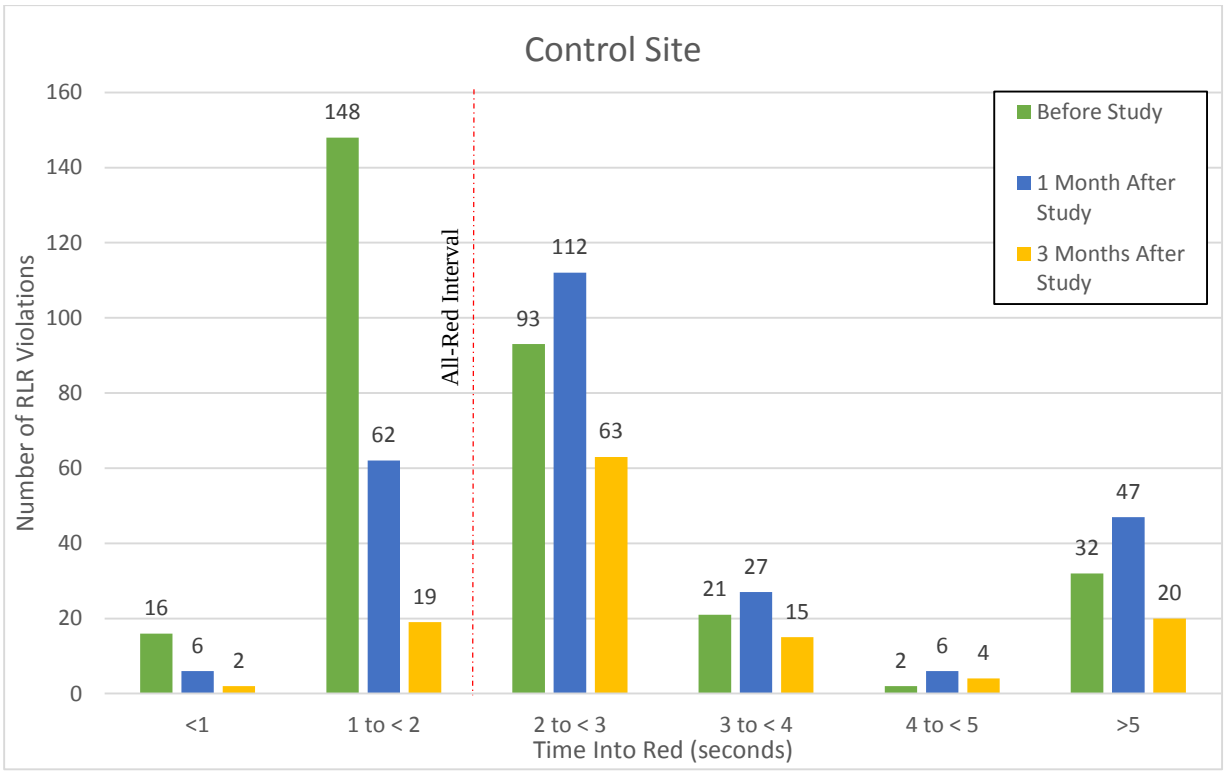


Figure 26. Time into red for the total RLR violations at the control sites

Figure 26, shows the left-turning movement time into red at the control intersections. 148 violations were observed between one second and two seconds after the onset of red, which was reduced by 58 percent for one month and by 87 percent for the three month periods. A total of 99 RLR violation after five seconds were also found at the control sites. This pose a safety concern as these drivers were entering the intersection while conflicting traffic had a green light.

To further expand, these times into red were classified in peak hour periods for a better understanding of the distribution of time into red by time of day. Figures 27 and 28 shows the RLR time into red for the morning and evening peak hours for the treatment and control sites respectively.

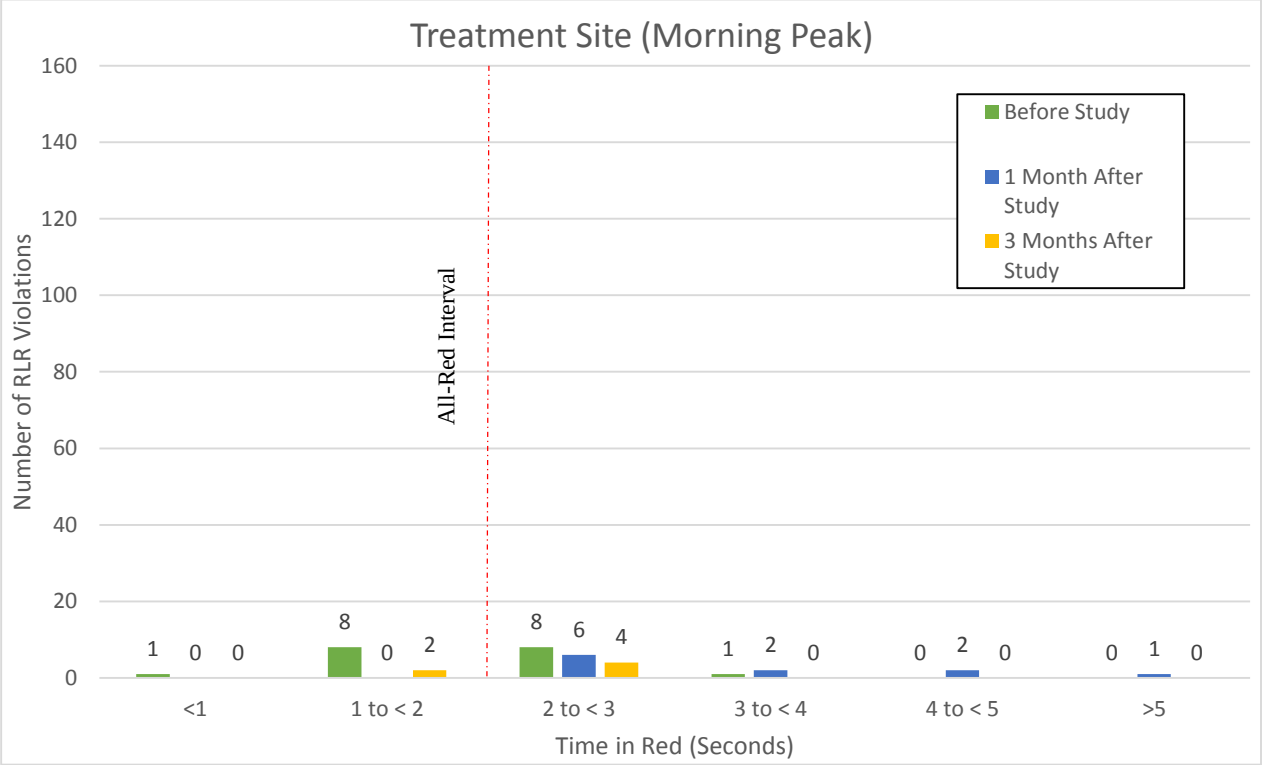


Figure 27. Time into red for the morning peak RLR violations at the treatment sites

As shown in Figure 27, a 51.4 percent of RLR violation occurred between two to three seconds and increased 23 percent in the one month period and again reduced by 53 percent in the three months period. No violations occurring after four seconds into the red were observed one month after installation.

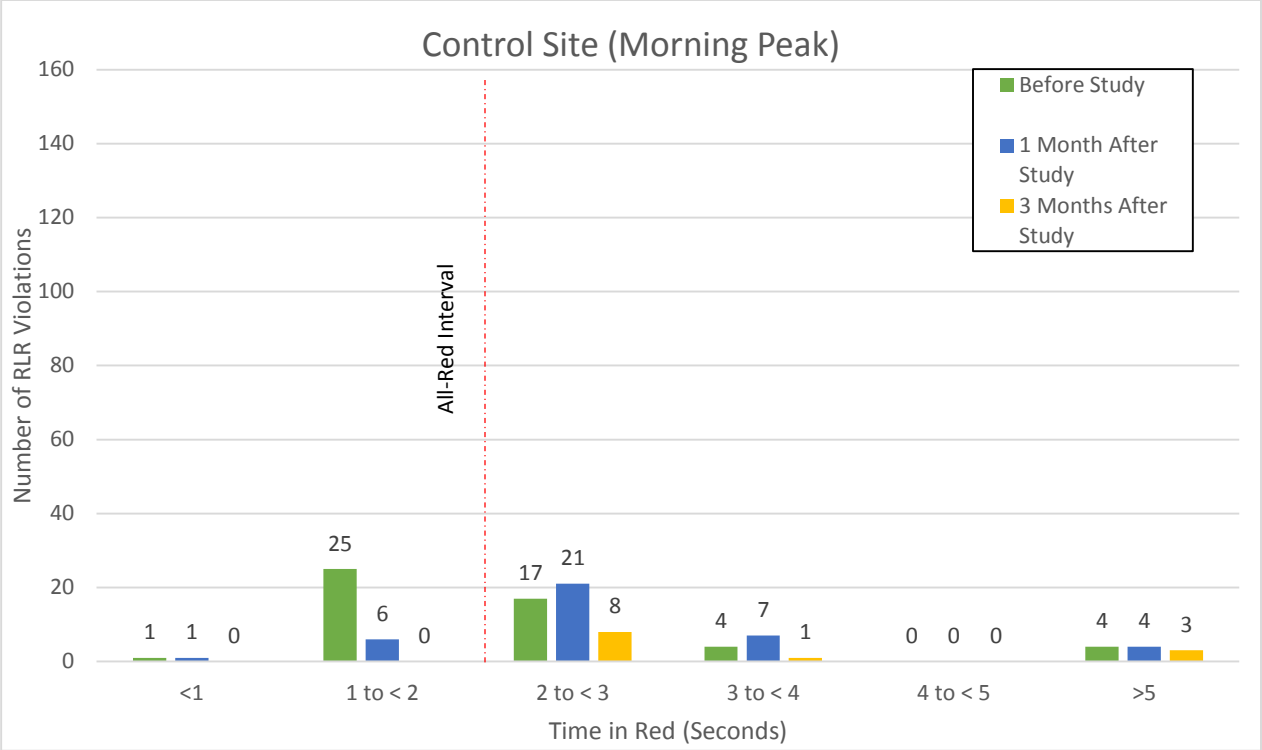


Figure 28.Time into red for the morning peak RLR violations at the control sites

Figure 28 shows the distribution of time into red for the morning peak hour at the control sites. Similar to treatment sites, most violations occurred between two to three seconds after the onset of red. For most time intervals, more violations were observed for the one month compared to the before and the three months after study at both treatment and control sites. For the control sites, it was found that few violations occurred after five seconds indicating intentional violations.

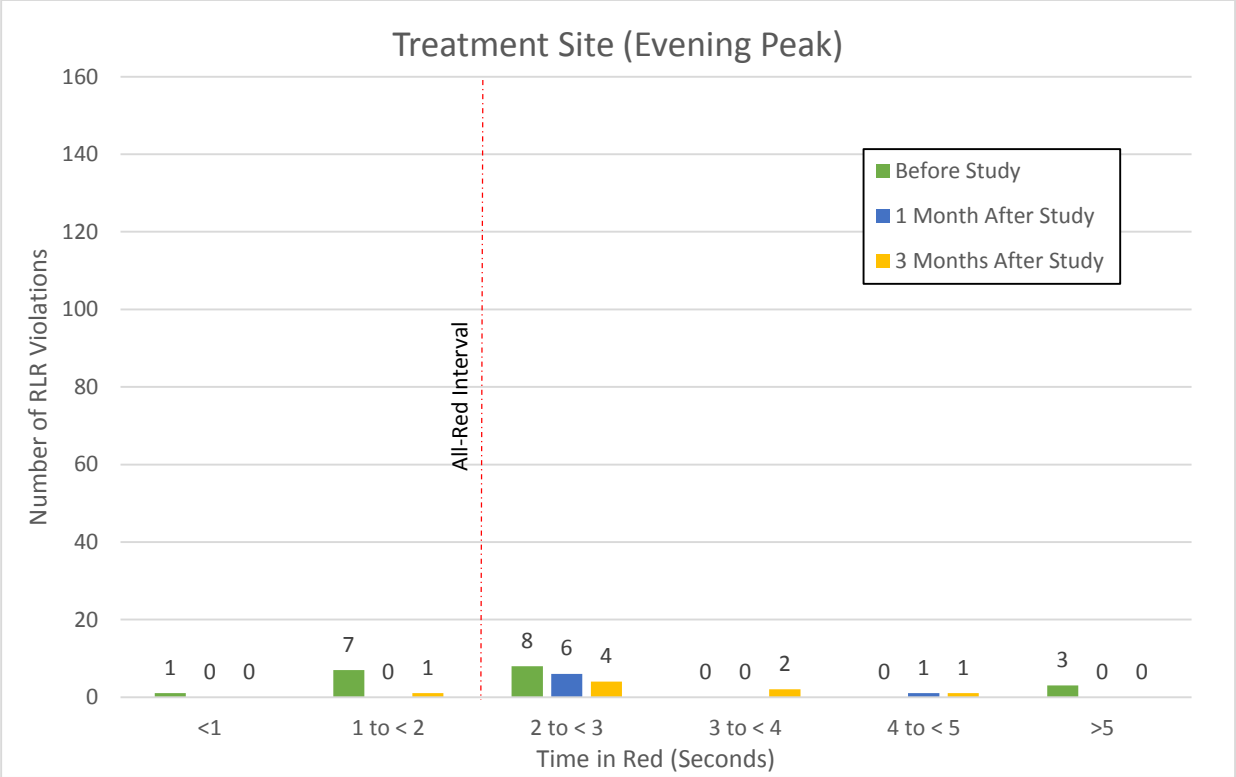


Figure 29.Time into red for the evening peak RLR violation at treatment site

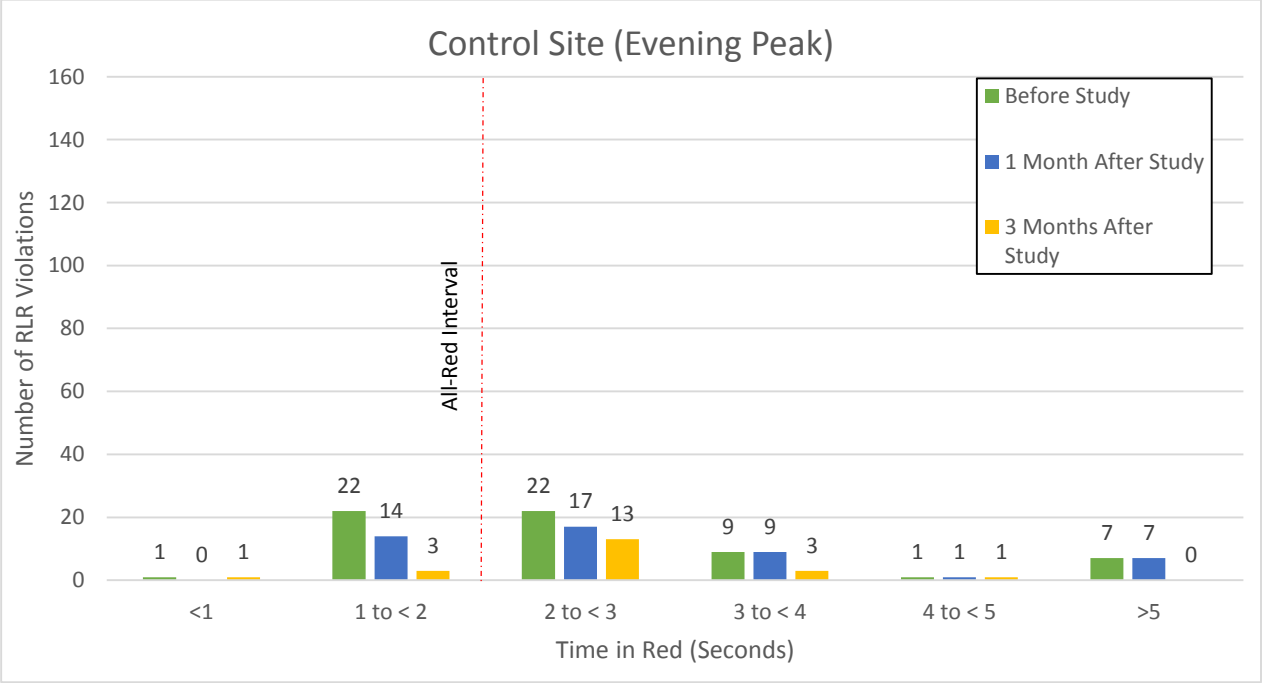


Figure 30.Time into red for the evening peak RLR violation at control site

As shown in Figure 29 and 30, a 40 percent of the violations occurred between two to three seconds after the onset of red indication during the evening peak hour. When the number of violations at the morning and evening peak hour that occurred after the five second interval is compared to the total violations in Figure 25 and 26, it was observed that most number of violations at treatment and control were occurred during off-peak hour. It was also noted, that some drivers during night time would disregard the traffic signal completely and violate without stopping when no vehicular traffic is present at the intersection, treating the traffic signal like it was a YIELD sign.

5.4 Violation Configurations and Vehicle Types

5.4.1 Background

This study investigates how the RLR violations occurred, if the violations were committed by the driver of a single vehicle or multiple vehicles travelling in a platoon or side by side. Mechanisms of RLR under different traffic conditions were investigated. How RLR decisions are made was determined through an examination of various violation configurations.

During the video data reduction, guidelines were developed to group the violations by the configuration and vehicle types shown in Figures 15 and 16. Violation configurations were coded 1 to 4 as shown below:

- A single vehicle violates the red light on a left turn lane was coded 1
- Two vehicles (travelling side by side) violate the red light on dual left turn lanes was coded 2
- Two or more vehicles in a platoon violate the red light on a left turn lane was coded 3
- Three or more vehicles in a platoon and travelling side by side violate the red light on dual left turn lanes was coded 4

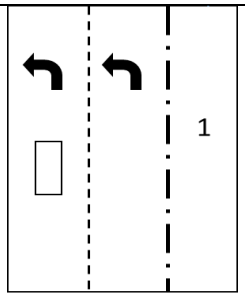
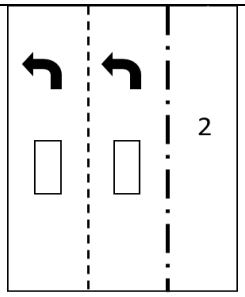
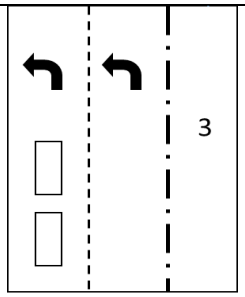
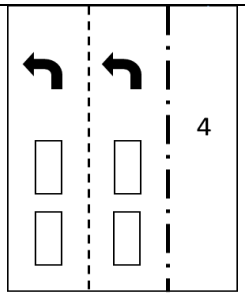
5.4.2 Results

5.4.2.1 Violation Configurations

RLR violations for the entire 24 hours for all the seven study intersections were combined. For each configuration type, the percentage of RLR violations were then calculated by dividing the number of violations that occurred in that configuration type by the total number of violations for that study period and multiplying by 100. For example, if 373 violations were recorded for the violation type

coded 1 during the before study, and total number of violation observed was 429, then percentage of violation that occurred in violation configuration coded ‘1’ was expressed as (373/429)*100, yielding 87 percent. All the violations for the treatment and control sites were combined for the before, one month after and three months after study period, respectively. Table 4 shows the number of violations (in percentage) for each of the four configuration types for the left tuning movement during the study period.

Table 4. Violation Configuration

Violation code	Violation Configuration	Violation in percentage		
		Before	1 month	3 months
1		87%	93%	86%
2		7%	4%	10%
3		6%	3%	4%
4		0%	0%	0%

From Table 4, it was found that a single vehicle making a left-turn coded 1 showed the highest percentage of RLR violations across all study periods. This violation type accounted for more than 85 percent of all the violations observed during the three study periods (before, one month, and three months after installation).

Two vehicles side by side making a dual left turn together (code 2) showed the second highest percentage of RLR violations during the before and one month after study periods (7 percent), closely followed by two or more vehicles in platoon coded 3 (6 percent). It was noted that most of the coded 3 violation were made when a truck made the left turn. Since the truck making a left turn is quite slow and the intersection already occupied, passenger cars would easily violate the red light signal with the truck. It is also possible that the truck blocked the view of the signal head to vehicles behind them. No violations were observed for configuration coded 4.

5.4.3.2 Violation by Vehicle Type

Over 90 percent of the RLR violations were committed by the drivers of passenger cars during all study periods. This finding is consistent with a previous study by Retting et al., where they reported that drivers who run a red light were more likely to be driving small cars (*25*). From Table 6, it is shown that the second highest percent (8 percent) of violating vehicle types is the pickup truck or van. Trucks and buses accounted for less than two percent of all vehicles that were involved in RLR. There was no event of recreational vehicle running a red light during the study periods. The percentages of RLR violations categorized by type of vehicle are shown in Table 5.

Table 5. RLR Violation by Vehicle Type

Vehicle Type	RLR Violations (%)		
	Before	**1 month**	**3 Month**
Motorcycle	0.7	0.7	0.0
Passenger Car	90.9	90.0	93.9
Pick-Up or Van	7.4	8.0	3.7
Bus	0.5	0.0	0.6
Truck	0.7	1.0	1.8
Recreational Vehicle	0.0	0.3	0.0

5.5 Police Schedule and Citations

The Overland Park Police Department was contacted for their support in this study. They were requested to maintain their unchanged enforcement structure same around the study areas after installation of the confirmation lights to accurately evaluate the effectiveness of the confirmation light at on-ramp signalized intersection. Table 7 shows the number of officers deployed and citations made each for before and after the installation of confirmation lights. It should be noted that the after installation period ranges from September 11, 2014 to February 26, 2015 and the before installation period ranges from August 1, 2014 to September 9, 2014. The information received from the Overland Park Police Department below does not accurately specify the intersection under study. However the indicated number represents coverage of the intersection and the nearby area. For example, the information provided for the treatment sites comprises of both I-435 & Quivera Road North and I-435 & Quivera Road South.

Table 6. Officers Deployed and Citations Made

Site Category		Officers Deployed		Citations made	
		Before Study	After Study	Before Study	After Study
Treatment Site	I-435 and Quivera Road N.	84	137	137	462
	I-435 and Quivera Road S.				
Control Site	I-435 and Antioch Road N.	11	70	39	247
	I-435 and Antioch Road S.				
	I-435 and Metcalf Avenue N.	28	65	51	187
	US 69 and 95th Street E.	23	34	48	171
	US 69 and 95th Street W.				

As shown in Table 6, the number of officers deployed after installation of the confirmation lights increased compared to before period for both treatment and control sites. One of the reasons as explained by the Overland Park Police Department was the ease in enforcing these areas due to confirmation lights.

The number citations made after the installation of the confirmation lights was higher than the before period for the treatment and the control sites. Upon enquiring with the Overland Park Police Department, it was found that with the help of confirmation lights, apprehending the violators became relatively easier; also the increased citations in the after period were the result of increased number of officers tasked to enforce the intersection.

This chapter showed descriptive statistics of the treatment and control site for the time of day based on violation rates, as well as the number of violations based on the time into red when the violation occurred. The next chapter will show the statistics further to determine if the differences found are statistically significant.

CHAPTER 6. STATISTICAL ANALYSIS FOR RLR VIOLATION

6.1 Comparison of RLR Violation Rates after Installation of Confirmation Lights

Studies show that effectiveness of road safety device is best determined from before-after crash data. These studies involve at least three years of before data and three years of after data (*26*). However, many communities prefer to know the effectiveness of the device shortly after its installation, hence in place of a crash analysis researchers used violation rates as a surrogate measure. In this study violation rates were studied for one month and three months after installation of confirmation lights.

6.1.1 Methodology

The RLR violation rate was the metric used to compare, one month after, and three months after installation of the confirmation lights. Violation rates were used instead of the actual number of violations to account for varying intersection volumes. RLR rates were expressed in 10,000 entering vehicles as shown previously in Equation 1.

Once a violation rate was determined for each data collection period, the change in the violation rates is determined using Equation 2.

$$\textbf{Change (\%)} = \frac{\hat{\pi}_i - \hat{\pi}_b}{\hat{\pi}_b} \times 100\% \qquad \textbf{Eq. 2}$$

Where: $\hat{\pi}_b$ = proportion of violation rate for before period; and

$\hat{\pi}_i$ = proportion of violation rate for after period *i*

To compare the calculated rates for the before, 1 month, and 3 months after installation of the confirmation lights, a test of proportions was used to determine if the changes in rate were statistically significant. The z-test was chosen as an appropriate method to determine the difference between two sample proportions (before and after data) which approximately follows the normal distribution and assumptions of the normal distribution.

The test of proportions was conducted for investigating the following cases:

1. The before study RLR violation rates versus the one month study RLR violation rates;

2. The before study RLR violation rates versus three months study RLR violation rates.

A sample data analysis is presented in the following section. Sample sizes n_1 and n_2 were 10,000 each and violations for I-435 and Quivera Road North before and after studies were 35.90 and 8.73 respectively. Thus, the proportions p_1 and p_2 were 0.00359 (0.3%) and 0.000873 (0.08%) respectively. A two-tailed test of proportions at 0.05 level of significance was chosen to be appropriate to determine if the positive or negative effect of confirmation lights with targeted enforcement on violations rates was significant. Following Equation 3 was used to calculate the pooled proportions of the sample from the population.

$$\mathbf{p = (p_1 + p_2)/ (n_1 + n_2)} \qquad \textbf{Eq. 3}$$

p = (35.90+8.73)/ (10,000+10,000) = 0.002232

Equation 4 was used to determine the Z-score.

$$\mathbf{Z = \frac{(p_1 + p_2)}{\sqrt{p(1 - p)}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}} \qquad \textbf{Eq. 4}$$

$$\mathbf{Z = 4.072}$$

n_1 = Total volume of vehicles observed during before period data collection;

n_2 = Total volume of vehicles observed during after period *i* data collection;

p_1 = Proportion of RLR violation rate for before period;

p_2 = Proportion of RLR violation rate for after period *i*; and

p = Pooled sample proportion.

The calculated z-test statistic above was then compared to a z table with $\alpha = 0.025$ to determine the significance at the 95 percent level of confidence. It was found from the table that if any z-test score was greater than 1.96, the resulting decrease in violation rate was statistically significant. Similarly, if the z-test score was less than -1.96, the resulting increase in violation rate was statistically significant.

6.1.2 Results of RLR Violations

Table 7 shows the results of the analysis for the left turning RLR at ramps. The table shows: the intersection, RLR violation recorded, number of vehicles counted, RLR rates per 10,0000 vehicles, percent change in violation rates between periods and the corresponding z-test statistics score.

Table7. Statistical Results of the RLR Violation Analysis

	Number of Violations			Number of Vehicles			Violation rate/10,000 Entering vehicles			Percent Change		z-test score	
Treatment Site	Before	1 month	3 month	Before	1 month	3 months	Before	1 month	3 month	1 month	3 months	1 month	3 months
I-435 & Quivera Road (NB)	44	11	21	12255	12603	13479	35.9	8.7	15.6	75.7	56.6	4.0[A]	2.8[A]
I-435 & Quivera Road (SB)	65	44	19	15652	22992	10293	41.5	19.1	18.5	53.9	55.6	2.8[A]	2.9[A]
Total	**109**	**55**	**40**	**27907**	**35595**	**23772**	**39.1**	**15.5**	**16.8**	**60.4**	**56.9**	**3.2[A]**	**2.9[A]**
Control Site													
I-435 & Antioch Road (NB)	54	29	17	8298	5294	5216	65.1	54.8	32.6	15.8	49.9	-1.0	1.4
I-435 & Antioch Road (SB)	61	56	28	16208	24760	16684	37.6	22.6	16.8	39.9	55.4	1.9	2.8[A]
I-435 & Metcalf Avenue (NB)	87	66	49	18046	24242	25110	48.2	27.2	19.5	43.5	59.5	2.4[A]	3.4[A]
US 69 & 95th Street (WB)	34	39	23	4905	5602	6699	69.3	69.6	34.3	-0.4	50.5	0.0	3.4[A]
US 69 & 95th Street (EB)	84	54	6	8813	7317	4277	95.3	73.8	14.0	22.6	85.3	1.7	7.7[A]
Total	**320**	**244**	**123**	**56270**	**67215**	**57986**	**56.9**	**36.3**	**21.2**	**36.2**	**62.7**	**1.8**	**3.7[A]**

[A]z-test score is statistically significant at 0.05 level of significance

Overall, the confirmation lights for left turn on-ramp movements showed positive results at the treatment site. Although the change in violation rates decreased from the one month to the three month study period, both intersections (I-435 & Quivera Road North and I-435 & Quivera Road South) where confirmation lights were installed showed a statistically significant reduction in RLR violation rates at the 0.05 level of significance.

For I-435 & Quivera Road North, the confirmation lights and officer presence were 56.6 percent three months after installation. Likewise, I-435 & Quivera Road South was found to have a 55.6% reduction in RLR three months after installation.

Overall, the decrease in RLR violations rates were substantial having greater than 50 percent reductions in RLR violations. Four of the five control sites were found to have a statistically significant reduction in RLR violations only in three months study period. Negative change in percent indicates an increase in violations rates.

In general, the confirmation lights combined with targeted enforcement have a positive impact in reducing the RLR violations on left turning movements towards the freeway ramp at the treatment sites. The lack of a clear reason for a similar reduction at the control sites limits the findings. Further analysis into the number of officers deployed and citations made per day was performed as shown in Table 8.

Table 8. Number of Officers Deployed and Citation Made Per Day

Site Category		Officers Deployed per day		Citations made per day	
		Before Study	After Study	Before Study	After Study
Treatment Site	Quivera N	2	0.81	3.34	2.86
	Quivera S				
Control Site	Antioch N	0.26	0.41	0.95	1.47
	Antioch S				
	Metcalf N	0.68	0.38	1.24	1.11
	US 69 E	0.56	0.20	1.17	1.01
	US 69 W				

Table 8 shows the conversion of these data into rates. Previously shown in Table 6 in Chapter 5, the Overland Park Police Department provided raw data on the number of times officers were tasked with traffic enforcement at the interchanges in this study, over periods that covered both the before and after periods. While there was a 55 percent increase in the number of citations issued per day at I-435 & Antioch, all other locations experienced a reduction in overall police activity during the study period. While this is an imperfect metric to evaluate the levels of police activity in the study area, it was the best method available for use at the time of this study, as the police department was unwilling by policy to provide more detailed information about individual officer activities. So it may be possible that there were other police activities overall that changed driver behavior throughout Overland Park during the study period which could not be quantified.

It may also be possible; however, that the activities associated with this study provided a wider change to the area. Specifically, the placement of the confirmation lights provided the police officers with a new location to enforce these intersections - a location on the nearby on-ramp. Consistent use of this location may change driver behavior not only at the treatment intersections, but also at other nearby interchanges. If this is the case, the control sites used for this study may have been affected by the treatment locations, which would mean that the control intersections might be more appropriately termed halo intersections. Without a means to resolve this from the current research, this question would need to be addressed in future work.

6.2 Statistical Analysis of Officers Deployed and Citations written

Change in enforcement structure for the after periods was checked using the raw data in Table 7 provided by the Overland Police Department. A chi-square test for goodness of fit at the 0.05 level of significance was performed to determine if the changes in officers deployed and citation written for the after study period were significant.

6.2.1 Methodology

Since the number of days for before (41 days) and after study periods (168 days) were different, the observed value of before study for both officers deployed and citation written were converted in terms of after study duration. For example, officers deployed at treatment sites for the before study period was 84 officers in 41 days. Therefore, the converted value for the before study will

be (84/41)* 168 = 344 officers in 168 days. The null and alternate hypotheses are stated respectively:

$H_{0:}$ There is no difference in number of officers deployed/citations made between before and after study periods; and

H_A: There is significant difference in officers deployed/citations made between before and after study period.

The formula for the chi-square Test for goodness of fit is shown in Equation 5.

$$\chi^2 = \sum \frac{(E - O)^2}{E} \qquad \textbf{Eq. 5}$$

Where χ^2 = calculated chi-square value;

E = expected frequency of RLR violation; and

O = observed frequency of RLR violation.

6.2.2 Results

6.2.2.1 Chi-Square Test for Officers Deployed

Table 9 shows the result for the chi-square tests for the before and after study periods at the treatment sites.

Table 7. Chi-Square Test for Officers Deployed at Treatment Sites

Study Period	Observed value	Expected value	Calculated chi-square test	Critical chi-square value	Null Hypothesis
Before Study	344.1	240.5	89.2	3.84	Rejected
After Study	137	240.5			

As shown, the observed value for the number of officers deployed in the before study is higher than the after study period when converted in terms of after study period duration. The calculated chi-square value was greater than the critical chi-square value, hence the null hypothesis was rejected indicating that at the 0.05 level of significance the difference in the officers deployed was significant. From Table 10, the reduction in the number of officers deployed for the after study period was significantly reduced when compared to the before study period. Table 10 shows the chi-square result for officers deployed at control sites.

Table 8. Chi-Square Test for Officers Deployed at Control Sites

Study Period	Observed value	Expected value	Calculated chi-square test	Critical chi-square value	Null Hypothesis
Before Study	254	211.5	17	3.84	Rejected
After Study	169	211.5			

The calculated chi-square value was greater than the critical chi-square value, hence the null hypothesis was rejected indicating that at the 0.05 level of significance the difference in the officers deployed is significant. From Table 10, the reduction in the number of officers deployed for the after study period was significantly reduced when compared to the before study period.

6.2.2.1 Chi-Square Test for Citations Written

Table 11 shows the result for chi-square test for before and after study periods at the treatment sites for citations written.

Table 9. Chi-Square Test for Citations Written at Treatment Sites

Study Period	Observed value	Expected value	Calculated chi-square test	Critical chi-square value	Null Hypothesis
Before Study	561.3	511.6	9.64	3.84	Rejected
After Study	462	511.6			

As shown, the observed value for the number of citations made in the before study was higher than the after study period when converted in terms of the after study period duration. The calculated chi-square value was greater than the critical chi-square value; hence the null hypothesis was rejected indicating that at the 0.05 level of significance the difference in the citations made was significant. From Table 11, the reduction in the number of citations made for the after study period was significantly reduced when compared to the before study period. Table 12 shows the chi-square result for citations written at control sites.

Table 10. Chi-Square Test for Citations Written at Control Sites

Study Period	Observed value	Expected value	Calculated chi-square test	Critical chi-square value	Null Hypothesis
Before Study	565.4	585.23	1.35	3.84	Failed to Reject
After Study	605	585.23			

Though the number of officers at the control sites was reduced during after study periods, the numbers of citations written were statistically the same as shown in the Table 12. The calculated chi-square value was less than the critical chi-square value, hence the null hypothesis was not rejected, indicating that at the 0.05 level of significance the difference in the citations made was not significant. This shows that the structure and level of enforcement was unchanged at the control sites for before and after study periods.

6.3 Before-After Effect on Violation Time into Red

Time into red was chosen as the secondary performance matric used to evaluate the confirmation lights, as it is the time elapsed prior to a violation occurring. A study conducted by Fitzsimmons et al. in 2007 and Lum et al. in 2003 showed that RLR violations occurring more than two seconds after the red signal indication are more likely to result in a crash compared to violations occurring less than one second after the all-red phase (*27*). During the all-red phase, vehicles entering the intersection in less than one second after the red indication usually clear the intersection prior to the vehicles on the cross-street getting the green light. In such instances, drivers of vehicles in the cross-street are exposed to fewer conflicts that could result in crash. However, drivers entering after two seconds of red signal indication may expose to increased risk of a crash. An analysis of before-after RLR violation time into red was conducted to determine if confirmation lights have any potential effect on driver behavior as to when a violation occurred. The null and alternate hypotheses are stated respectively as:

H_o: Confirmation lights with targeted enforcement have no effect on the frequency of RLR violation time into red; and

H_a: Confirmation lights with targeted enforcement have an effect on the frequency of RLR violation time into red.

6.3.1 Methodology

After the videos were reduced, all the RLR violations were categorized into two groups: group 1 consisted of all the RLR violations which occurred within two seconds after the onset of red, and group 2 consisted of the RLR violations that occurred more than two seconds after the onset of red. Two seconds was chosen since Overland Park had a minimum of 1.8 seconds for the all-red interval. Any RLR violations occurring more than 1.8 seconds after the onset of red have a high probability

of resulting in a crash. Due to the small sample size of the RLR violation time into red, 2x2 contingency tables were used for analyzing the data for each site category (treatment and control sites). Table 13 shows an example of 2x2 contingency table with the frequency of RLR violations, which occurred less than two seconds and after two seconds during the before and one month after study periods at the treatment sites.

Table 11. Contingency Table for RLR Violation Frequency at the Treatment Sites

Study Period	Number of Violations		Total
	≤ 2 seconds	> 2 seconds	
Before	57	48	105
1 month after	4	30	34
Total	61	78	

A chi-square of independence was chosen as the statistical method to determine if there exists a relationship between the two nominal variables: violation times after the red indication, and confirmation light presence (before and after study periods). A chi-square test was chosen to be appropriate method to compare counts of categorical responses between the two independent groups (before and after study periods). A chi-square analysis was performed with the understanding that the confirmation lights with visible targeted enforcement may have an effect on the frequency on RLR violations on on-ramp signalized intersections. The formula for the chi-square test of independence is shown in Equation 6.

$$\chi^2 = \sum \frac{(E - O)^2}{E} \qquad \textbf{Eq. 6}$$

Where χ^2 = calculated chi-square value;

E = expected frequency of RLR violation; and

O = observed frequency of RLR violation.

In order to find the chi-square value, the expected frequency for each column I and row j in Table 13 above was calculated using Equation 7.

$$\mathbf{E_{ij} = \frac{T_i \times T_j}{N}} \qquad \textbf{Eq. 7}$$

Where E_{ij} = the expected frequency for the cell in the ith row and the jth column;

T_i = the total number of subjects in the ith row;

T_j= the total number of subjects in the jth column; and

N = the total number of subjects in the table.

Table 14 shows the expected frequency of Table 13.

Table 12. Expected Frequency

Study Period	Number of Violations		Total
	≤ 2 seconds	> 2 seconds	
Before	46.08	58.92	105.00
1 month after	14.92	19.08	34.00
Total	61.00	78.00	139.00

A chi-square value was computed as follows:

$$\chi^2 = \sum \frac{\mathbf{(E-O)^2}}{\mathbf{E}} = \frac{(46.08 - 57)^2}{46.08} + \frac{(58.92 - 48)^2}{58.92} + \frac{(14.92 - 4)^2}{14.92} + \frac{(19.08 - 30)^2}{19.08} = \mathbf{18.85}$$

6.3.2 Results

6.3.2.1 Chi-Square Test for the Before and one Month After Periods

Table 15 shows the chi-square test result for the before and one month after study periods.

Table 13. Chi-Square Test for Before and 1 Month After Study

Site Category	Study Period	Number of Violations		Chi-square Value	p-value
		≤ 2 seconds	> 2 seconds		
Treatment	Before	57	48	18.86	< 0.0001
	1 month after	4	30		
Control	Before	164	148	41.03	< 0.0001
	1 month after	68	192		

As shown, the number of RLR violations which occurred within two seconds after the red indication were higher than the number of RLR violations occurred more than two seconds after the red indication at all the study sites for before installation of confirmation lights. After the one month period a substantial increase in RLR violations occurring more than two seconds after onset of red signal. At the 0.05 level of significance, the chi-square statistical analysis shows p-values less than 0.05 indicating that there was statistical significance between the two groups. The null hypothesis can be rejected indicating that the confirmation lights with targeted enforcement have an effect on the distribution of RLR violation time into red.

6.3.2.2 Chi-Square Test for before and 3 Month After Study

Table 16 shows the results of the chi-square test and their associated p-values for the before and three months after violation time into red at treatment and control sites. As previously discussed, more RLR violations occurred within two seconds after the red indication than the number of violations which occurred more than two seconds after the red indication for the before study period compared to three months after study period. At the 0.05 level of significance, the obtained p-values for the treatment and control sites is greater than 0.05 for the chi-square test, which indicates that there exists a relationship between the confirmation light with targeted enforcement and the distribution of RLR violation time into red. The null hypothesis is rejected, indicating that there is a probable effect of the confirmation light with targeted enforcement on the distribution of RLR violation time into red.

Table 14. Chi-Square Test for Before and 3 Months After Study

Site Category	Study Period	Number of Violations		Chi-square Value	p-value
		≤ 2 seconds	> 2 seconds		
Treatment	Before	57	48	11.15	0.008
	3 months after	9	30		
Control	Before	164	148	45.46	<0.0001
	3 months after	21	102		

This chapter showed the statistical results for the violation rates between before and after installation periods and statistical analysis for time into red. Following chapter outlines the findings and recommendations drawn from results and statistical analysis

CHAPTER 7. FINDINGS AND RECOMMENDATIONS

RLR violations at the on-ramp signalized intersections are always a safety concern for communities in the United States since these locations as claimed by officers are difficult to enforce compared to signalized four-leg intersections. Also, driver behavior at these on-ramp locations are different for RLR violations since once violated the red signal it is found to be highly difficult to apprehend the violator among the high volumes on freeways. Many communities have opted for automated red light cameras (high-cost countermeasure) which studies have shown to be an effective system in reducing RLR violations and related crashes. However, automated enforcement is sometimes not feasible or legal in some communities. Confirmation light systems, a low-cost engineering countermeasure, are another alternative in mitigating RLR violations and associated crashes.

This research study evaluated confirmation lights at two signalized intersections in the City of Overland Park, Kansas. Two treatment intersections were identified by working directly with the Overland Park Traffic Engineering Department, and the Overland Park Police Department.

Ideally, most studies evaluating the effectiveness of a countermeasure rely on at least three to five years of before and after crash data. However, due to the limited timeframe on this study, a before-after violation study was used as a surrogate to crash analysis to evaluate the effectiveness of the confirmation lights. This study was completed with the understanding that a decrease or an increase in RLR violations would be similar to possible decreases or increases in RLR crashes based on traffic exposure.

7.1 Summary of Findings

In general, the one month after violation study saw a 60.4 percent reduction in a left-turn RLR violation rates at the treatment sits and 31.8 percent reduction at the control site. Treatment sites for one month study period were statistically significant at the 95 percent level of confidence. At the treatment sites, the violation study three months after the installation of the confirmation lights saw a 56.92 percent decrease in RLR violation rates, which is statically significant, and 60.16 percent decrease (statistically significant) at control sites. Considering the reduction at both the study periods indicate that confirmation lights had a positive effect in reducing the RLR violation in the short and long term periods. These findings are consistent with the study reported by Reddy et al. (2008), Boakye (2014) where they saw 25 percent and 57.4 percent reduction respectively in the violation after the implementation of the confirmation lights. However, the statistical results

show that the changes in officers' deployment and citations at the control sites were not increased. Hence, those reductions could be result of a possible halo effect from the treatment sites.

Results of the analysis of the time into red shows that most violations for the before study occurred between one and two seconds after the onset of the red phase of the signal. RLR violations more than five seconds after the indication of red signal were also observed at the all the study intersections. Some of the violators did not come to a complete stop at the stop line and proceeded through the intersection.

The chi-square test showed statistical significant (0.05 level of significance) on RLR violation time into red for both the one month and the three months study periods at both treatment and control sites. This indicates that the confirmation light countermeasure had a relation with time into red. But the results revealed an increase in time into red. No practical speculation can be made as to the reason for this.

More than 80 percent of the violations were single vehicle violations. Multiple vehicles running red lights side by side were found to be second highest and accounted for about five percent. No observations were recorded by the research team on three or more vehicles in platoon and travelling side by side. Passenger cars accounted for more than 90 percent of the RLR events in each of the study periods, which matches the large portion of if commuter traffic generally at these locations

As shown in Chapter 6, after determining the officers deployed and citations written per day at the control cites, the treatment sites may have impacted the RLR rates at the control sites, transforming them into spillover sites. Upon enquiring with the Overland Park Police Department, it was learned that the police officers found the confirmation lights to be a useful new tool and a new way of enforcing the on-ramp intersections. Overall, the finding of this study showed that confirmation lights when used in combination with enforcement can have a beneficial impact in reducing the RLR violations and related crashes at on-ramp signalized intersection.

7.2 Future Research

This study evaluated the effectiveness of confirmation lights with targeted enforcement at signalized on-ramp intersections in Overland Park, Kansas after one and three months after installation. It is recommended that

- Additional violation studies should be conducted for three to five years after installation of confirmation lights to assess the long-term impact of confirmation lights on reducing RLR with crash data analysis.
- Further analysis is needed to determine the area of influence of officers enforcing intersections from on-ramps. It is possible that future studies may need control sites located at much farther distances from the treatment sites.

REFERENCES

1. Insurance Institute for Highway Safety. Red Light Running, March 2014. http://www.iihs.org/iihs/topics/t/red-light-running/qanda. Accessed January 26, 2015.

2. Federal Highway Administration. Making Intersections Safer: A Toolbox of Engineering Countermeasures to Reduce Red-Light Running. Informational Report. Institute of Transportation Engineers, Washington, DC, 2003.

3. Mohamedshah, Y.M., L.W. Chen, and F.M. Council. Association of Selected Intersection Factors with Red-Light-Running Crashes. Institute transportation Engineers, Washington DC, 2000.

4. Boakye, K. Evaluation of Blue Confirmation Lights on Red Light Running at Signalized Intersections in Lawrence, Kansas : A Case Study, Master's Thesis, The University of Kansas, Lawrence, Kansas, 2014.

5. Manual on Uniform Traffic Control Device (MUTCD). 2009 Edition. http://mutcd.fhwa.dot.gov/ Accessed October 24, 2013.

6. Bonneson, J., and K. Zimmerman. Red Light Running Handbook: An Engineer's Guide to Reduce Red Light Related Crashes. Report FHWA/TX-05/0-4196-P1. Texas Transportation Institute, Texas A&M University, College Station, TX, 2004.

7. Hallmark, S., N. Oneyear, and T. McDonald. Toolbox of Countermeasures to Reduce Red Light Running. Center for Transportation Research and Education, Iowa State University, Ames, IA, 2012.

8. Insurance Institute for Highway Safety. Automated Enforcement http://www.iihs.org/iihs/topics/laws/automated_enforcement/enforcementtable?topicName=red-light-running. Accessed April 1, 2015.

9. Fitzsimmons, E.J., S. Hallmark, T. McDonald, M. Orellana, and D. Matulac. The Effectiveness of Iowa's Automated Red Light Running Enforcement Programs. Center for Transportation Research and Education, Iowa State University, Ames, IA, 2007.

10. Cunningham, C.M., and J.S. Hummer. Evaluating the Use of Red Light Running Photographic Enforcement Using Collisions and Red Light Running Violations. Institute for Transportation Research and Education, North Carolina State University, Raleigh, NC, 2004.

11. Tarawneh, T.M., V.A. Singh, and P.T. McCoy. Investigation of Effectiveness of Media Advertising and Police Enforcement in Reducing Red-Light Violations. *Transportation Research Record* 1693, TRB, National Research Council, Washington, D.C., 1999, pp. 37-45.

12. Baugley, C.J. Running the Red at Signals on High-Speed Roads. Traffic Engineering and Control, 1988, pp. 415-420.

25. R.H. Wortman, J.M. Witkowski, and Thomas C. Fox. Traffic Characerisitics During Signal Change Intervals. Transportation Research Record 1027, *Transportation Research Board*, Washington, D.C., 1985.

14. Millar, L. and Generowicz, B. A Study to Assess the Effectiveness of Varying Levels and Types of Enforcement on Driver Behavior at Urban Signalized Intersections. Department of Civil Engineering, Western Australia Institute for Technology. 1979.

15. Cooper, P.J. Effects of Increased Enforcement at Urban Intersections on Driver Behavior and Safety. Road Safety Branch, Canada Ministry of Transport. Undated

16. Zaal, D. Traffic Law Enforcement: A Review of the Literature. Report No. 53. Institute for Road Safety Research, Leidschendam, The Netherlands, April 1994.

17. Hsu, P., J. Smith, and E. Rice. Red Light Signal Enforcement. FHWA, U.S. Department of Transportation, Washington, D.C., 2009

18. Lindheimer, T. Long-Term Effects of the Red-Signal Indication Light and factors That Lead to Red Light Running, PhD. Dissertation, The University of Kansas, Lawrence, Kansas, 2014.

19. Reddy, V., M. Abdel-Aty, and S. Pinapaka. Evaluation of Innovative Safety Treatments. A Study of the Effectiveness of White Enforcement Lights. Florida Department of Transportation. January, 2008.

20. Minnesota Local Technical Assistance Program. 2009 Local Operational research Assistance (OPERA) Program Annual Report. University of Minnesota, Minneapolis, Minnesota, 2009.

21. Bankhead, K & Herms, B.F., Reducing accidents by selective enforcement. Traffic Digest Review, 1970, 18p. 1-38.

22. Tarko, A., G. Davis, N. Saunier, T. Sayed, and S. Washington. White Paper. Surrogate Measures of Safety. ANB20 (3) Subcommittee on Surrogate Measures of Safety. ANB20 Committee on Safety Data Evaluation and Analysis, 2009.

23. Bonneson, J., K. Zimmerman, and M. Brewer. Engineering Countermeasures to Reduce Red Light-Running. Report No. FHWA/TX-03/4027-2. Texas Department of Transportation, Austin, Texas, August 2002.

24. Kamyab, A., T. McDonald, and J.J. Stribiak. Red Light Running in Iowa: The Scope, Impact, and Possible Implications. Center for Transportation Research and Education, Iowa State University, Ames, 2000.

25. Retting, R.A., and A.F. Williams. Characteristics of Red Light Violators: Results of a Field Investigation. National Safety Council and Elsevier Science Ltd. *Journal of Safety Research*. Vol. 27, No. 1. 1996, pp. 9-15.

26. Nicolson, A.J. The Variability of Accident Counts. Accident Analysis and Prevention, Vol. 17, No. 1, 1985, pp. 47-56.

27. Lum, K. M. and Wong, Y. D. (2003). Impacts of Red Light Camera on Violation Characteristics. Journal of Transportation Engineering, November/December, 648-656

APPENDIX A

Reduced RLR Violation Data for Before and After Studies

BEFORE STUDY RLR VIOLATIONS

Treatment Sites

Table A1. Before Study at Intersection of I-435 & Quivera North (24 hours) 26th August 2014

Comments	Number of vehicle	Quivera & I 435 (Northbound)							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left				
Waited a long time for green eventually ran	2	Passenger Car	307	1		12:17:20 a.m.	12:17:20 a.m.	1	1
Didn't even stop	2	Passenger Car	0		1	2:07:58 a.m.	2:07:58 a.m.	1	1
Didn't even stop	2	Passenger Car	0	1		3:34:18 a.m.	3:34:18 a.m.	1	1
Waited a long time for green eventually ran	1	Passenger Car	300+		1	5:02:20 a.m.	5:02:20 a.m.	1	1
	3	Pickup truck	2.3	1		7:43:03a.m.	7:43:03a.m.	1	1
	2	Passenger Car	1.8	1		9:36:12 a.m.	9:36:12 a.m.	1	1
Ran together	5	Semi- Truck	1.68	1		10:04:35 a.m.	10:04:35 a.m.	1	2
	2	Passenger Car	1.9		1	10:04:35 a.m.	10:04:35 a.m.	1	2
Ran together	2	Passenger Car	1.1		1	2:15:59 p.m.	2:15:59 p.m.	2	3
	2	Passenger Car	1.1		1	2:15:59 p.m.	2:15:59 p.m.	2	3
	2	Passenger Car	1		1	2:27:59 p.m.	2:27:59 p.m.	1	1
	2	Passenger Car	1.3	1		3:46:00 p.m.	3:46:00 p.m.	1	1
Ran together	2	Passenger Car	1.1	1		7:14:42 p.m.	7:14:42 p.m.	2	3
	2	Passenger Car	1.6	1		7:14:42 p.m.	7:14:42 p.m.	2	3

Table A2. Before Study at Intersection of I-435 & Quivera North (24 hours) 27th August 2014

Comments	Number of vehicle	Quivera & I 435 (Northbound)							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
Waited a long time for green eventually ran	2	Passenger Car	300+	1		3:05:07a.m.	3:05:07a.m.	1	1
Waited a long time for green eventually ran	2	Passenger Car	300+		1	4:06:51 a.m.	4:06:51 a.m.	1	1
Didn't even stop	2	Passenger Car	300+	1		4:57:21 a.m.	4:57:21 a.m.	1	1
Didn't even stop	2	Passenger Car	46 secs	1		5:45:19 a.m.	5:45:19 a.m.	1	1
Ran Together	4	School Bus	0.8	1		7:11:14 a.m.	7:11:14 a.m.	2	3
	2	Passenger Car	1.2	1		7:11:14 a.m.	7:11:14 a.m.	2	3
	2	Passenger Car	2.1	1		7:25:88 a.m.	7:25:88 a.m.	1	1
	2	Passenger Car	2.4		1	7:51:04 a.m.	7:51:04 a.m.	1	1
Ran Together	2	Passenger Car	1.1	1		8:13:84 a.m.	8:13:84 a.m.	1	2
	2	Passenger Car	3.1		1	8:13:84 a.m.	8:13:84 a.m.	1	2
	2	Passenger Car	1.8	1		9:34:32 a.m.	9:34:32 a.m.	1	1
	2	Passenger Car	1.7		1	10:22:60 a.m.	10:22:60 a.m.	1	1
	2	Passenger Car	2		1	10:28:08 a.m.	10:28:21:08a.m.	1	1
	2	Passenger Car	1.7		1	10:49:34a.m.	10:49:34a.m.	1	1
	2	Passenger Car	1.9	1		5:02:42 p.m.	5:02:42 p.m.	1	1
	2	Passenger Car	1.7		1	5:12:91p.m.	5:12:91p.m.	1	1
	2	Passenger Car	1.3	1		5:21:27p.m.	5:21:27p.m.	1	1
	2	Passenger Car	1.2	1		6:37:81p.m.	6:37:81p.m.	1	1

Table A3. Before Study at Intersection of I-435 & Quivera North (24 hours) 28th August 2014

Comments	Number of vehicle	Quivera & I 435 (Northbound)							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
Never Stopped	3	Pickup	100+	1		5:02:50a.m.	5:02:50a.m.	1	1
	2	Passenger Car	1.1	1		7:49:44a.m.	7:49:44a.m.	1	1
	2	Passenger Car	1.6			8:07:38a.m.	8:07:38a.m.	1	1
	2	Passenger Car	1.6	1		10:54:94a.m.	10:54:94a.m.	1	1
	2	Passenger Car	1.9	1		3:17:02p.m.	3:17:02p.m.	1	1
	2	Passenger Car	1.1	1		3:35:47p.m.	3:35:47p.m.	1	2
	2	Passenger Car	1.8		1	3:35:47p.m.	3:35:47p.m.	1	2
	2	Passenger Car	2.3		1	5:40:17p.m.	5:40:17p.m.	1	1
	2	Passenger Car	73	1		6:08:88p.m.	6:08:88p.m.	1	1
	2	Passenger Car	1.8		1	6:10:30p.m.	6:10:30p.m.	1	1
Waited a long time for green eventually ran	2	Passenger Car	300+	1		11:26:17p.m.	11:26:17p.m.	1	1

Table A4. Before Study at Intersection of I-435 & Quivera South (24 hours) 26th August 2014

Comments	Number of vehicle	Quivera & I 435 (Southbound)							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	1	1		5:07:39.698a.m.	5:07:39.698a.m.	1	1
	2	Passenger Car	1.5	1		6:55:29.760a.m.	6:55:29.760a.m.	1	1
	2	Passenger Car	1.9		1	7:46:14.370a.m.	7:46:14.370a.m.	1	1
	2	Passenger Car	2.2	1		7:48:14.432a.m.	7:48:14.432a.m.	1	1
	2	Passenger Car	2.1	1		7:56:14.399a.m.	7:56:14.399a.m.	1	1
	3	Pickup	2.1		1	11:23:08.201a.m	11:23:08.201a.m	1	1
	3	Pickup	1.7		1	1:05:09.099p.m.	1:05:09.099p.m.	1	1
	2	Passenger Car	1.9		1	1:49:08.467p.m.	1:49:08.467p.m.	1	1
	2	Passenger Car	1.4	1		2:27:08.084p.m.	2:27:08.084p.m.	1	1
	2	Passenger Car	2.1		1	3:13:07.390p.m.	3:13:07.390p.m.	1	1
	2	Passenger Car	1.4	1		3:33:07.165p.m.	3:33:07.165p.m.	1	1
	2	Passenger Car	1.2	1		3:43:06.991p.m.	3:43:06.991p.m.	1	1
	2	Passenger Car	1.5	1		3:45:07.259p.m.	3:45:07.259p.m.	1	1
	2	Passenger Car	0.9	1		4:45:48.064p.m.	4:45:48.064p.m.	1	2
Ran together	2	Passenger Car	2.5		1	4:45:48.064p.m.	4:45:48.064p.m.	1	2
	2	Passenger Car	2.3	1		5:06:47.642p.m.	5:06:47.642p.m.	1	1
	2	Passenger Car	2	1		5:09:07.712p.m.	5:09:07.712p.m.	1	1
	2	Passenger Car	1.7	1		5:20:47.244p.m.	5:20:47.244p.m.	1	1
	2	Passenger Car	1.8	1		5:37:06.519p.m.	5:37:06.519p.m.	1	1
	2	Passenger Car	1.2	1		6:09:18.433p.m.	6:09:18.433p.m.	2	3
Ran together	2	Passenger Car	2.3	1		6:09:18.433p.m.	6:09:18.433p.m.	2	3
	2	Passenger Car	2	1		7:22:48.328p.m.	7:22:48.328p.m.	1	1
Cones were laid, weird setting	2	Passenger Car	Excess		1	9:09:39.108p.m.	9:09:39.108p.m.	1	1
Doesn't Even stop	2	Passenger Car	Excess		1	9:11:03.709p.m.	9:11:03.709p.m.	1	1

Table A5. Before Study at Intersection of I-435 & Quivera South (24 hours) 27th August 2014

Comments	Number of vehicle	Quivera & I 435 (Southbound)							
	Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code		Inner Left lane	Outer left lane				
	3	Van	1.3	1		6:47:10.569a.m.	6:47:10.569a.m.	1	1
	2	Passenger car	2.5		1	7:24:15.498a.m.	7:24:15.498a.m.	1	1
	2	Passenger car	1.7	1		7:34:15.530a.m.	7:34:15.530a.m.	1	1
	2	Passenger car	1.8	1		8:55:31.691a.m.	8:55:31.691a.m.	1	1
	2	Passenger car	3	1		10:02:12.313a.m	10:02:12.313a.m.	1	1
	2	Passenger car	1.2	1		10:32:11.730a.m	10:32:11.730a.m.	1	1
	2	Passenger car	2.1		1	10:57:11.169a.m	10:57:11.169a.m.	1	1
Ran Together	2	Passenger car	1.5	1		1:05:07.569p.m.	1:05:07.569p.m.	1	2
	2	Passenger car	3		1	1:05:07.569p.m.	1:05:07.569p.m.	1	2
	4	Bus	4.5		1	1:47:06.598p.m.	1:47:06.598p.m.	1	1
	2	Passenger car	3.2	1		2:03:11.169p.m.	2:03:11.169p.m.	1	1
	2	Passenger car	1.6	1		2:25:09.152p.m.	2:25:09.152p.m.	1	1
	2	Passenger car	3.3		1	2:47:08.737p.m.	2:47:08.737p.m.	1	1
	2	Passenger car	1.9	1		3:09:08.457p.m.	3:09:08.457p.m.	1	1
	2	Passenger car	2.1	1		3:11:08.272p.m.	3:11:08.272p.m.	1	1
serious violator	2	Passenger car	73		1	4:08:52.921p.m.	4:08:52.921p.m.	1	1
Ran Together after	2	Passenger car	122	1		4:08:52.921p.m.	4:08:52.921p.m.	1	2
waiting a lot.	1	Motorcycle	123		1	4:08:52.921p.m.	4:08:52.921p.m.	1	2
	2	Passenger car	2.5	1		5:09:07.059p.m.	5:09:07.059p.m.	1	1
	2	Passenger car	2.3	1		5:27:46.970p.m.	5:27:46.970p.m.	1	1
	3	Pick Up	2.1		1	6:31:07.579p.m.	6:31:07.579p.m.	1	1
	3	Pick Up	1.6	1		7:56:02.174p.m.	7:56:02.174p.m.	1	1
	2	Passenger car	2.5		1	9:06:19.815p.m.	9:06:19.815p.m.	1	1

Table A6. Before Study at Intersection of I-435 & Quivera South (24 hours) 28th August 2014

Comments	Number of vehicle	Quivera & I 435 (Southbound)							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configuratio
	Code			Inner Left lane	Outer left lane				
Didn't Stop	3	Pickup	300+	1		3:05:15.539a.m.	3:05:15.539a.m.	1	1
Didn't Stop	3	Pickup	300+		1	4:19:02.040a.m.	4:19:02.040a.m.	1	1
Didn't stop	2	Passenger Car	21.8		1	5:45:05.904a.m.	5:45:05.904a.m.	1	1
	2	Passenger Car	1.4	1		5:47:45.639a.m.	5:47:45.639a.m.	1	1
	2	Passenger Car	1.8		1	7:07:14.906a.m.	7:07:14.906a.m.	1	1
	2	Passenger Car	2.1	1		7:48:16.352a.m.	7:48:16.352a.m.	1	1
	2	Passenger Car	2.7		1	12:05:05.588p.m.	12:05:05.588p.m.	1	1
	2	Passenger Car	2	1		12:39:04.527p.m.	12:39:04.527p.m.	1	1
	2	Passenger Car	2.9		1	1:25:06.955p.m.	1:25:06.955p.m.	1	1
	2	Passenger Car	1.5	1		1:47:06.975p.m.	1:47:06.975p.m.	1	1
	2	Passenger Car	1.8	1		2:47:05.313p.m.	2:47:05.313p.m.	1	1
	2	Passenger Car	1.2	1		3:01:06.974p.m.	3:01:06.974p.m.	1	1
	2	Passenger Car	2.6	1		5:46:26.412p.m.	5:46:26.412p.m.	1	1
	2	Passenger Car	1.8	1		6:17:41.814p.m.	6:17:41.814p.m.	1	1
	2	Passenger Car	2.3		1	7:15:24.947p.m.	7:15:24.947p.m.	1	1
	2	Passenger Car	22.4	1		8:28:28.920p.m.	8:28:28.920p.m.	1	1
	2	Passenger Car	3.6		1	9:25:50.979p.m.	9:25:50.979p.m.	1	1
	2	Passenger Car	23.7		1	11:42:19.024p.m.	11:42:19.024p.m.	1	1

Volumes

I-435 & Quivera North

Table A7. 26th August 2014

Time	Volume	
	Inner lane	Outer lane
12-2a.m.	21	17
2-4 a.m.	8	11
4-5 a.m.	6	3
5-6 a.m.	36	17
6- 9 a.m.	465	272
9-12p.m.	412	228
12-2 p.m.	326	203
2-4 p.m.	414	247
4-6 p.m.	394	249
6-8 p.m.	264	149
8-10p.m.	166	98
10p.m.-12a.m.	65	38

Table A8. 27th August 2014

Time	Volume	
	Inner	Outer
12-2 a.m.	17	20
2-4a.m.	12	3
4-5a.m.	11	5
5-7a.m.	119	59
7-9 a.m.	379	236
9-12 p.m.	397	235
12-2p.m.	376	222
2-4p.m.	389	249
4-6 p.m.	368	280
6-8p.m.	279	187
8-10p.m.	185	82
10-12p.m.	66	33

Table A9. 28th August 2014

Time	Volume	
	Inner	Outer
12-3 A.m.	Camera Angle Changed	
3-5a.m.	13	7
5-7a.m.	123	59
7-8a.m.	246	158
9-12p.m.	355	221
12-2p.m.	383	199
2-4p.m.	414	263
4-6p.m.	394	249
6-8p.m.	289	144
8-10p.m.	212	101
10-12A.m.	69	38

I-435 & Quivera South

Table A10. 26th August 2014

Time	Volume	
	Inner	Outer
12-2a.m.	9	13
2-4a.m.	6	5
4-7a.m.	231	115
7-9a.m.	476	300
9-12A.m.	555	359
12-2p.m.	489	344
2-4p.m.	469	353
4-6p.m.	496	323
6-8P.m.	368	276
8-10p.m.	264	243
10-12a.m.	Cones laid	

Table A11. 27th August 2014

Time	Volume	
	Inner	Outer
12-3A.m.	Cones laid	
3-5a.m.	14	11
5-7a.m.	177	102
7-9a.m.	482	306
9-12p.m.	505	356
12-1p.m.	185	143
1-2p.m.	201	151
2-4p.m.	411	304
4-6p.m.	456	303
6-8p.m.	381	290
8-10p.m.	359	284
10-12A.m.	51	57

Table A12. 28th August 2014

Time	Volume	
	Inner	Outer
12-2a.m.	14	10
2-4a.m.	10	7
4-7a.m.	198	115
7-8a.m.	295	167
8-9a.m.	Camera Angle changed	
9-12p.m.	472	291
12-2p.m.	446	305
2-4p.m.	345	284
4-5:20p.m.	Camera Angle changed	
5:20-6p.m.	112	77
6-8p.m.	333	259
8-10p.m.	308	245
10-12a.m.	79	57

Control Sites

Table A13. Before Study at Intersection of I-435 & Antioch North (24 hours) 26th August 2014

Comments	Number of vehicle	1435 & Antioch North (2014-08-26)							
	Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code		Inner Left lane	Outer Lane				
	2	car	1.267	1	0	6:56:47.338a.m.	6:56:47.338a.m.	1	1
	2	car	1.599	0	1	6:59:47.792a.m.	6:59:47.792a.m.	1	1
	2	car	1.332	0	1	7:44:03.886a.m.	7:44:03.886a.m.	1	1
	2	car	3.333	0	1	7:46:06.011a.m.	7:46:06.011a.m.	1	1
	2	car	1.139	1	0	9:04:19.045a.m.	9:04:19.045a.m.	1	1
	2	car	1.733	0	1	9:19:19.608a.m.	9:19:19.608a.m.	1	1
Both Truck and car crosses the red light sa.m.e time									
	3	truck	1.534	0	1	10:19:19.928a.m.	10:19:19.928a.m.	2	3
	2	car	2.934	0	1				
	2	car	1.132	0	1	10:29:49.749a.m.	10:29:49.749a.m.	1	1
	2	car	2.333	0	1	11.15.04.108a.m.	11.15.04.109a.m.	1	1
	2	car	2.133	0	1	11.23.23.926a.m.	11.23.23.926a.m.	1	1
	2	car	1.398	0	1	11.38.23.490a.m.	11.38.23.490a.m.	1	1
	3	truck	1.797	0	1	1.05.54.934p.m.	1.05.54.934p.m.	1	1
	2	car	2	0	1	1.35.05.526p.m.	1.35.05.526p.m.	1	1
	2	car	1.6	0	1	1.43.25.277p.m.	1.43.25.277p.m.	1	1
	2	car	1.4	1	0	2.06.45.189p.m.	2.06.45.189p.m.	1	1
	2	car	1.332	0	1	2.43.25.528p.m.	2.43.25.528p.m.	1	1
	2	car	1.266	1	0	2.55.05.751p.m.	2.55.05.751p.m.	1	1
	2	car	1.6	1	0	3.31.45.555p.m.	3.31.45.555p.m.	1	1
	2	car	0.999	0	1	3.49.59.656p.m.	3.49.59.656p.m.	1	1
	2	car	1.933	1	0	6.17.08.720p.m.	6.17.08.720p.m.	1	1

Table A14. Before Study at Intersection of I-435 & Antioch North (24 hours) 27th August 2014

Comment	Number of vehicle	1435 & Antioch North(2014-08-27)							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer Lane				
	2	car	1.132	1	0	6.43.19.207a.m.	6.43.19.207a.m.	1	1
	2	car	1.267	0	1	6.56.49.354a.m.	6.56.49.354a.m.	1	1
	2	car	2.266	1	0	7.34.07.140a.m.	7.34.07.140a.m.	1	1
	2	car	2.069	0	1	8.38.07.089a.m.	8.38.07.089a.m.	1	1
	2	car	2.433	1	0	9.25.20.499a.m.	9.25.20.499a.m.	1	1
	2	car	1.066	1	0	9.46.19.215a.m.	9.46.19.215a.m.	1	1
	2	car	1.4	1	0	11.45.04.752a.m.	11.45.04.752a.m.	1	1
	2	car	1.401	0	1	1.03.55.170p.m.	1.03.55.170p.m.	1	1
	3	truck	1.266	1	0	2.10.05.839p.m.	2.10.05.839p.m.	1	1
	2	car	1.334	1	0	2.30.06.081p.m.	2.30.06.081p.m.	1	1
Doesn't Stop	2	car	300+	1	0	2.47.31.917p.m.	2.47.31.917p.m.	1	1
	3	van	1.264	1	0	2.51.46.325p.m.	2.51.46.325p.m.	1	1
	2	car	2.6	0	1	3.29.59.404p.m.	3.29.59.404p.m.	1	1
	2	car	1.6	1	0	6.39.53.392p.m.	6.39.53.392p.m.	1	1
	2	car	1.4	1	0	8.04.41.497	8.04.41.498	1	1

Table A15. Before Study at Intersection of I-435 & Antioch North (24 hours) 28th August 2014

Comments	Number of vehicle	1435 & Antioch North (2014-08-28)							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer Lane				
	2	car	1.232	0	1	7.32.07.084a.m.	7.32.07.084a.m.	1	1
	2	car	1.4	1	0	9.40.21.241a.m.	9.40.21.241a.m.	1	
	2	car	1.866	1	0	9.44.51.822a.m.	9.44.51.822a.m.	1	1
	2	car	1.199	1	0	9.55.21.914a.m.	9.55.21.914a.m.	1	1
	3	truck	2.267	0	1	9.59.52.363a.m.	9.59.52.363a.m.	1	1
	2	car	1.268	0	1	10.17.51.560a.m.	10.17.51.560a.m.	1	1
	2	car	1.731	1	0	10.32.52.163a.m.	10.32.52.163a.m.	1	1
	2	car	2.803	0	1	10.49.23.433a.m.	1049.23.433a.m.	1	1
	2	car	1.465	1	0	10.53.52.215a.m.	10.53.52.215a.m.	1	1
	3	van	1.38	1	0	1.31.18.846p.m.	1.31.18.846p.m.	1	1
	2	car	1.599	0	1	1.40.06.141p.m.	1.40.06.141p.m.	1	1
Truck red light crossed but U turned	3	truck	300+	1	0	2.19.06.986p.m.	2.19.06.986p.m.	1	1
	2	car	0.867	1	0	2.25.05.295p.m.	2.25.05.295p.m.	1	1
	2	car	1.33	1	0	2.45.05.948p.m.	2.45.05.948p.m.	1	1
	2	car	1.865	1	0	3.53.52.970p.m.	3.53.52.970p.m.	1	1
Car doesnot stop t red light	2	car	300+	1	0	6.33.682.54p.m.	6.33.682.54p.m.	1	1
2 cars at time	2	car	1.2	1	1	6.44.51.637p.m.	6.44.51.637p.m.	1	2
	2	car	2.067						
Stoped and crossed	2	car	300+	1	0	6.50.847.07p.m.	6.50.847.07p.m.	1	1
	2	car	1.467	1	0	6.58.19.997p.m.	6.58.19.997p.m.	1	1

Table A16. Before Study at Intersection of I-435 & Antioch South (24 hours) 26th August 2014

Any Comment or Confusion mention here.	Number of vehicle	Antioch South							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	3	Pick up truck	2		1	6:05:00.404a.m.	6:05:00.404a.m.	1	1
	2	Passsenger car	1.7		1	1:59:17.236p.m.	1:59:17.236p.m.	1	1
	2	Passsenger car	1.9	1		2:29:16.817p.m.	2:29:16.817p.m.	1	1
	2	Passsenger car	1.5	1		3:12:39.483p.m.	3:12:39.483p.m.	1	1
Ran Together	2	Passsenger car	1.7	1		3:53:10.279p.m.	3:53:10.279p.m.	1	2
	2	Passsenger car	3		1	3:53:10.279p.m.	3:53:10.279p.m.	1	2
	2	Passsenger car	1.9		1	4:01:26.092p.m.	4:01:26.092p.m.	1	1
	2	Passsenger car	67.5		1	4:01:26.092p.m.	4:01:26.092p.m.	1	1
	2	Passsenger car	1.5		1	4:07:25.767p.m.	4:07:25.767p.m.	1	1
Ran Together	2	Passsenger car	1.5	1		5:09:56.060p.m.	5:09:56.060p.m.	1	2
	2	Passsenger car	2.4		1	5:09:56.060p.m.	5:09:56.060p.m.	1	2
	2	Passsenger car	2.2	1		5:12:15.864p.m.	5:12:15.864p.m.	1	1
	2	Passsenger car	2.3	1		5:16:11.403p.m.	5:16:11.403p.m.	1	1
	2	Passsenger car	0.8	1		5:18:54.816p.m.	5:18:54.816p.m.	1	1
	2	Passsenger car	2.6		1	5:26:03.946p.m.	5:26:03.946p.m.	1	1
Ran Together	2	Passsenger car	3.5	1		5:33:04.332p.m.	5:33:04.332p.m.	1	2
	2	Passsenger car	3.5		1	5:33:04.332p.m.	5:33:04.332p.m.	1	2
	2	Passsenger car	43.8	1		8:01:44.441p.m.	8:01:44.441p.m.	1	1
	2	Passsenger car	1.7	1		8:05:19.248p.m.	8:05:19.248p.m.	1	1
	2	Passsenger car	1.7	1	1	10:00:20.238p.m.	10:00:20.238p.m.	1	1
	2	Passsenger car	2.5	1		10:26:28.813p.m.	10:26:28.813p.m.	1	1

Table A17. Before Study at Intersection of I-435 & Antioch South (24 hours) 27th August 2014

Any Comment or Confusion mention here.	Number of vehicle	Antioch S							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger car	1.6	1		7:45:13.864a.m.	7:45:13.864a.m.	1	1
	2	Passenger car	5.5	1		9:24:33.095a.m.	9:24:33.095a.m.	1	1
	2	Passenger car	1.8		1	1:54:17.423p.m.	1:54:17.423p.m.	1	1
	2	Passenger car	2.4		1	2:39:17.629p.m.	2:39:17.629p.m.	1	1
	2	Passenger car	1.7	1		3:21:00.299p.m.	3:21:00.299p.m.	1	1
	2	Passenger car	2.5	1		3:36:00.258p.m.	3:36:00.258p.m.	1	1
	2	Passenger car	1.9		1	3:37:40.526p.m.	3:37:40.526p.m.	1	1
	2	Passenger car	2.3	1		3:42:40.536p.m.	3:42:40.536p.m.	1	1
	2	Passenger car	1.7	1		3:44:20.536p.m.	3:44:20.536p.m.	1	1
	2	Passenger car	1.9		1	3:47:40.809p.m.	3:47:40.809p.m.	1	1
	2	Passenger car	2.7		1	3:50:50.747p.m.	3:50:50.747p.m.	1	1
	2	Passenger car	2.2	1		4:11:26.982p.m.	4:11:26.982p.m.	1	1
	2	Passenger car	1.4	1		4:19:26.928p.m.	4:19:26.928p.m.	1	1
	2	Passenger car	2.5		1	4:25:37.338p.m.	4:25:37.338p.m.	1	1
	2	Passenger car	2.5	1		5:07:37.343p.m.	5:07:37.343p.m.	1	1
	2	Passenger car	2.4		1	6:19:20.332p.m.	6:19:20.332p.m.	1	1
	3	Pickup	2.4		1	6:27:40.074p.m.	6:27:40.074p.m.	1	1
	2	Passenger car	2.7		1	6:52:39.648p.m.	6:52:39.648p.m.	1	1
Ran Together	2	Passenger car	1.5	1		7:16:07.753p.m.	7:16:07.753p.m.	1	2
	2	Passenger car	2.9		1	7:16:07.753p.m.	7:16:07.753p.m.	1	2
	2	Passenger car	2.8		1	11:06:23.383p.m.	11:06:23.383p.m.	1	1

Table A18. Before Study at Intersection of I-435 & Antioch South (24 hours) 28th August 2014

Any Comment or Confusion mention here.	Number of vehicle	Antioch S							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configuration
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	3.4	1		12:32:25.725a.m.	12:32:25.725a.m.	1	1
	2	Passenger Car	4.1		1	5:33:33.081a.m.	5:33:33.081a.m.	1	1
Ran Together	2	Passenger Car	1.7	1		10:50:05.537a.m.	10:50:05.537a.m.	2	3
	2	Passenger Car	3.9	1		10:50:05.537a.m.	10:50:05.537a.m.	2	3
	2	Passenger Car	2.2		1	11:09:16.653a.m.	11:09:16.653a.m.	1	1
	2	Passenger Car	2.5	1		12:14:50.693p.m.	12:14:50.693p.m.	1	1
	2	Passenger Car	2.5	1		12:40:50.308p.m.	12:40:50.308p.m.	1	1
	2	Passenger Car	2.6		1	3:24:22.099p.m.	3:24:22.099p.m.	1	1
	2	Passenger Car	3.2		1	3:36:01.985p.m.	3:36:01.985p.m.	1	1
	2	Passenger Car	2.5		1	3:50:52.741p.m.	3:50:52.741p.m.	1	1
	3	Pick Up Truck	2.2	1		3:59:22.22p.m.	3:59:22.22p.m.	1	1
	2	Passenger Car	2	1		4:07:22.169p.m.	4:07:22.169p.m.	1	1
	2	Passenger Car	2.5	1		4:46:32.566p.m.	4:46:32.566p.m.	1	1
	2	Passenger Car	3.1	1		5:07:32.064p.m.	5:07:32.064p.m.	1	1
	1	Motorcycle	2.1	1		5:23:52.158p.m.	5:23:52.158p.m.	1	1
	2	Passenger Car	2.5		1	6:03:21.953p.m.	6:03:21.953p.m.	1	1
	2	Passenger Car	2.1	1		6:09:21.764p.m.	6:09:21.764p.m.	1	1
	2	Passenger Car	3.2		1	7:08:52.259p.m.	7:08:52.259p.m.	1	1
	2	Passenger Car	2.4	1		7:30:28.694p.m.	7:30:28.694p.m.	1	1

Table A19. Before Study at Intersection of I-435 & Metcalf Avenue North (24 hours) 26th August 2014

Any Comment or Confusion mention here.	Number of vehicle	Type of vehicle	Metcalf and 110th						
			Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configuration
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	1.5	1		7:10:45.101a.m.	7:10:45.101a.m.	1	1
	2	Passenger Car	1.8	1		7:13.28.891a.m.	7:13.28.891a.m.	1	1
	2	Passenger Car	1	1		7:22:49.120a.m.	7:22:49.120a.m.	1	1
	1	Motorcycle	2.5	1		7:32.08.945a.m.	7:32.08.945a.m.	1	1
	2	Passenger Car	1	1		7:53:08.725a.m.	7:53:08.725a.m.	1	1
	2	Passenger Car	2.6		1	7:55:28.783a.m.	7:55:28.783a.m.	1	1
	2	Passenger Car	2.5		1	8:51:31.414a.m.	8:51:31.414a.m.	1	1
	2	Passenger Car	2.1		1	8:53:51.278a.m.	8:53:51.278a.m.	1	1
	2	Passenger Car	1.8	1		9:16:50.182a.m.	9:16:50.182a.m.	1	1
	2	Passenger Car	1.5	1		9:43:52.963a.m.	9:43:52.963a.m.	1	1
	2	Passenger Car	2	1		11:34:09.079a.m.	11:34:09.079a.m.	1	1
	2	Passenger Car	2.2	1		12:09:51.606p.m.	12:09:51.606p.m.	1	1
	2	Passenger Car	1.5	1		12:16:10.017p.m.	12:16:10.017p.m.	1	1
	2	Passenger Car	1.5	1		2:03:17.057p.m.	2:03:17.057p.m.	1	1
	2	Passenger Car	1.4	1		3:10:30.493p.m.	3:10:30.493p.m.	1	1
	2	Passenger Car	0.7	1		3:35:42.330p.m.	3:35:42.330p.m.	1	1
	2	Passenger Car	0.8	1		3:42:00.205p.m.	3:42:00.205p.m.	1	1
	2	Passenger Car	1.6	1		3:46:11.813p.m.	3:46:11.813p.m.	1	1
	2	Passenger Car	1.9	1		3:58:48.163p.m.	3:58:48.163p.m.	1	1
Ran Together	2	Passenger Car	1.5	1		4:24:40.135p.m.	4:24:40.135p.m.	1	2
	2	Passenger Car	2.5		1	4:24:40.135p.m.	4:24:40.135p.m.	1	2
	2	Passenger Car	2.2		1	4:27:00.937p.m.	4:27:00.937p.m.	1	1
	2	Passenger Car	1.6		1	4:29:23.410p.m.	4:29:23.410p.m.	1	1
	3	Van	1.2	1		4:34.01.082p.m.	4:34.01.082p.m.	1	1
	2	Passenger Car	2.2		1	4:36:20.952p.m.	4:36:20.952p.m.	1	1
	2	Passenger Car	2.3	1		4:50:21.040p.m.	4:50:21.040p.m.	1	1
	2	Passenger Car	1.1	1		5:13:40.939p.m.	5:13:40.939p.m.	1	1
Ran Together	2	Passenger Car	1.4	1		5:16:00.808p.m.	5:16:00.808p.m.	1	2
	2	Passenger Car	1.7		1	5:16:00.808p.m.	5:16:00.808p.m.	1	2
	2	Passenger Car	1.8	1		5:32:20.072p.m.	5:32:20.072p.m.	1	1
	2	Passenger Car	1.8		1	5:37:00.053p.m.	5:37:00.053p.m.	1	1
	2	Passenger Car	1.6	1		5:39:20.239p.m.	5:39:20.239p.m.	1	1
	2	Passenger Car	1.7	1		5:46:19.942p.m.	5:46:19.942p.m.	1	1
	2	Passenger Car	2	1		6:38:22.776p.m.	6:38:22.776p.m.	1	1
	2	Passenger Car	1.5	1		8:09:42.326p.m.	8:09:42.326p.m.	1	1
	2	Passenger Car	2.7	1		8:28:54.024p.m.	8:28:54.024p.m.	1	1

Table A20. Before Study at Intersection of I-435 & Metcalf Avenue North (24 hours) 27th August 2014

Any Comment or Confusion mention here.	Number of vehicle	Type of vehicle	Metcalf and 110th						
			Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configuratio
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	3.6		1	7:48:31:048 a.m.	7:48:31:048 a.m.	1	1
	2	Passenger Car	1.7		1	7:57:51.208a.m.	7:57:51.208a.m.	1	1
Ran Together	2	Passenger Car	2.1	1		8:51:31.511a.m.	8:51:31.511a.m.	1	2
	3	Pickup truck	2.1		1	8:51:31.511a.m.	8:51:31.511a.m.	1	2
	2	Passenger Car	2.4	1		8:53:51.371a.m.	8:53:51.371a.m.	1	1
	2	Passenger Car	1.9	1		9:10:26.632a.m.	9:10:26.632a.m.	1	1
	2	Passenger Car	2.6		1	9:26:36.015a.m.	9:26:36.015a.m.	1	1
	2	Passenger Car	1.4	1		9:47:12.805a.m.	9:47:12.805a.m.	1	1
	2	Passenger Car	0.9	1		10:22:17.454a.m.	10:22:17.454a.m.	1	1
	2	Passenger Car	1.3	1		10:28:46.030a.m.	10:28:46.030a.m.	1	1
Ran Together	2	Passenger Car	2	1		10:46:24.879a.m.	10:46:24.879a.m.	1	2
	2	Passenger Car	2		1	10:46:24.879a.m.	10:46:24.879a.m.	1	2
	2	Passenger Car	1.2	1		11:19:26.539a.m.	11:19:26.539a.m.	1	1
	2	Passenger Car	1.6	1		11:55:10.443a.m.	11:55:10.443a.m.	1	1
	2	Passenger Car	1.8	1		1:25:28.858p.m.	1:25:28.858p.m.	1	1
	2	Passenger Car	2.8	1		1:38:05.280p.m.	1:38:05.280p.m.	1	1
	2	Passenger Car	2.5	1		3:00.00.683p.m.	3:00.00.683p.m.	1	1
	2	Passenger Car	0.7	1		3:10:30.434p.m.	3:10:30.434p.m.	1	1
	2	Passenger Car	3.8		1	3:14:42.573p.m.	3:14:42.573p.m.	1	1

Table A21. Before Study at Intersection of I-435 & Metcalf Avenue North (24 hours) 28th August 2014

Any Comment or Confusion mention here.	Number of vehicle	Metcalf							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configuration
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	1.1	1		7:15:51.761a.m.	7:15:51.761a.m.	1	1
	2	Passenger Car	2.5	1		7:43:52.040a.m.	7:43:52.040a.m.	1	2
Ran Together	5	Truck	2.6		1	8:16:32.234a.m.	8:16:32.234a.m.	1	2
	2	Passenger Car	3.9	1		8:16:32.234a.m.	8:16:32.234a.m.	1	2
Ran Together	2	Passenger Car	1.3	1		9:44:04.191a.m.	9:44:04.191a.m.	1	2
	3	Pick up	2.6		1	9:44:04.191a.m.	9:44:04.191a.m.	1	2
	3	Van	0.8	1		9:51:57.624a.m.	9:51:57.624a.m.	1	1
	2	Passenger Car	1.4	1		10:07:51.689a.m.	10:07:51.689a.m.	1	1
	2	Passenger Car	2.1		1	10:14:28.460a.m.	10:14:28.460a.m.	1	1
	2	Passenger Car	3.1	1		10:19:06.775a.m.	10:19:06.775a.m.	1	1
	2	Passenger Car	1.5	1		10:55:59.746a.m.	10:55:59.746a.m.	1	1
	2	Passenger Car	0.8	1		10:55:59.278a.m.	10:55:59.278a.m.	1	1
	2	Passenger Car	2.9		1	12:05:41.238p.m.	12:05:41.238p.m.	1	1
	2	Passenger Car	1.8	1		12:37:11.761p.m.	12:37:11.761p.m.	1	1
	2	Passenger Car	3.2	1		1:21:17.503p.m.	1:21:17.503p.m.	1	1
	2	Passenger Car	0.8	1		1:35:59.705p.m.	1:35:59.705p.m.	1	1
	2	Passenger Car	2.7		1	2:17:59.717p.m.	2:17:59.717p.m.	1	1
	2	Passenger Car	1.8	1		2:22:11.497p.m.	2:22:11.497p.m.	1	1
	2	Passenger Car	2.2		1	2:47:23.387p.m.	2:47:23.387p.m.	1	1
	2	Passenger Car	0.9		1	3:03:59.596p.m.	3:03:59.596p.m.	1	1
	2	Passenger Car	1.9	1		3:14:43.860p.m.	3:14:43.860p.m.	1	1
	2	Passenger Car	1.6		1	3:16:49.930p.m.	3:16:49.930p.m.	1	1
	2	Passenger Car	1.6	1		3:52:32.387p.m.	3:52:32.387p.m.	1	1
	2	Passenger Car	1.3		1	4:01:17.467p.m.	4:01:17.467p.m.	1	1
	2	Passenger Car	3.3		1	4:19:57.628p.m.	4:19:57.628p.m.	1	1
	2	Passenger Car	1.9	1		4:24:38.038p.m.	4:24:38.038p.m.	1	1
	2	Passenger Car	2	1		4:33:58.119p.m.	4:33:58.119p.m.	1	1
	2	Passenger Car	2.4	1		5:34:37.679p.m.	5:34:37.679p.m.	1	1
	2	Passenger Car	3.2		1	6:39:52.186p.m.	6:39:52.186p.m.	1	1
	2	Passenger Car	2.2	1		7:22:26.989p.m.	7:22:26.989p.m.	1	1
	2	Passenger Car	2	1		8:01:24.320p.m.	8:01:24.320p.m.	1	1
	2	Passenger Car	2	1		11:26:10.201p.m.	11:26:10.201p.m.	1	1

Table A22. Before Study at Intersection of US-69 & 95th Street West (24 hours) 26th August 2014

Comments	Number of vehicle	US69 & 95th(E)						
		Type of vehicle	Seconds into red	Northbound Approach	Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane				
Car doesn't stop	2	car	300+	1	6:40:13.50a.m.	6:40:13.50a.m.	1	1
Car doesn't stop	2	car	300+	1	9:12:13.006a.m.	9:12:13.006a.m.	1	1
	2	car	3.003	1	9:43:38.654a.m.	9:43:38.654a.m.	1	1
	2	car	2.269	1	11:15:05.194a.m.	11:15:07.463a.m.	1	1
	2	car	2.469	1	12:56:50.188a.m.	12:56:52.657a.m.	1	1
Car doesn't stop	2	car	300+	1	3:20:38.150p.m.	3:20:38.150p.m.	1	1
Car doesn't stop	2	car	300+	1	3:35:04.313a.m.	3:35:04.313a.m.	1	1
Car doesn't stop	3	Van	300+	1	6:10:55.819a.m.	6:10:55.819a.m.	1	1
Car doesn't stop	2	car	300+	1	7:05:26a.m.	7:05:26a.m.	1	1
Car doesn't stop	2	car	300+	1	7:48:46.391a.m.	7:48:46.391a.m.	1	1

Table A23. Before Study at Intersection of US-69 & 95th Street West (24 hours) 27th August 2014

Comments	Number of vehicle	US69 & 95th(W)						
		Type of vehicle	Seconds into red	Northbound Approach	Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane				
Car doesn't stop	2	car	300+	1	5:32:59.357a.m.	5:32:59.357a.m.	1	1
Car doesn't stop	2	car	300+	1	5:37:12.457a.m.	5:37:12.457a.m.	1	1
	2	car	3.006	1	8:10:18.756a.m.	8:10:21.762a.m.	1	1
Car doesn't stop	2	car	300+	1	9:16:50.405a.m.	9:16:50.405a.m.	1	1
Car doesn't stop	2	car	300+	1	9:34:59.087a.m.	9:34:59.087a.m.	1	1
	2	car	1.334	1	9:54:14.897a.m.	9:54:16.897a.m.	1	1
	2	car	2.202	1	9:55:31.965a.m.	9:55:33.767a.m.	1	1
	2	car	0.865	1	1:30:03.024p.m.	1:30:03.889p.m.	1	1
	2	car	1.535	1	4:10:18.697p.m.	4:10:20.232p.m.	1	1
Car doesn't stop	2	car	300+	1	4:21:40.398p.m.	4:21:40.398p.m.	1	1
	2	car	2.064	1	9:06:22.539p.m.	9:06:24.605p.m.	1	1

Table A24. Before Study at Intersection of US-69 & 95th Street West (24 hours) 28th August 2014

Comment	Number of vehicle	US69 & 95th(W)						
		Type of vehicle	Seconds into red	Northbound Approach	Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane				
Car doesn't stop	2	car	300+	1	6:52:23.776a.m.	6:52:23.776a.m.	1	1
Car doesn't stop	2	car	300+	1	8:42:34.082a.m.	8:42:34.082a.m.	1	1
Car doesn't stop	2	car	300+	1	8:53:56.916a.m.	8:53:56.916a.m.	1	1
	2	car	1.125	1	9:34.47.928a.m.	9:34.47.928a.m.	1	1
	2	car	1.201	1	12:10:09.520a.m.	12:10:10.520a.m.	1	1
	2	car	0.801	1	12:41:48.351p.m.	12:41:48.351p.m.	1	1
	2	car	1.268	1	4:25:04.039p.m.	4:25:05.307p.m.	1	1
	2	car	2.269	1	5:45:08.980p.m.	5:45:11.249p.m.	1	1
	2	car	1.669	1	6:16:44.793p.m.	6:16:46.462p.m.	1	1
Car doesn't stop	2	car	300+	1	6:44:36.576p.m.	6:44:36.576p.m.	1	1
Car doesn't stop	2	car	300+	1	9:15:41.646p.m.	9:15:42.314p.m.	1	1
Car doesn't stop	2	car	300+	1	9:53:18.738p.m.	9:53:18.738p.m.	1	1
Car doesn't stop	2	car	300+	1	10:47:11.602p.m.	10:47:11.602p.m.	1	1

Table A25. Before Study at Intersection of US-69 & 95th Street East (24 hours) 26th August 2014

Comments	Number of vehicle	US69 & 95th(E)						
		Type of vehicle	Seconds into red	Northbound Approach	Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane				
	3	pick up	1.602	1	6:13:55.32a.m.	6:13:55.32a.m.	1	1
	2	car	1.068	1	7:42:54.30a.m.	7:42:54.30a.m.	1	1
	2	car	1.735	1	7:46:14.61a.m.	7:46:14.61a.m.	1	1
	2	car	0.868	1	7:56:14.18a.m.	7:56:14.18a.m.	1	1
	2	car	1.468	1	7:57:54.08a.m.	7:57:54.08a.m.	1	1
	2	car	1.935		8:34:09.33a.m.	8:34:09.33a.m.	1	1
	2	car	2.536	1	8:43:09.22a.m.	8:43:09.22a.m.	1	1
	2	car	1.401	1	10:13:09.48a.m.	10:13:09.48a.m.	1	1
	2	car	1.802	1	10:23:40.13a.m.	10:23:40.13a.m.	1	1
	3	pickup	1.335	1	11:05:40.21a.m.	11:05:40.21a.m.	1	1
	2	car	2.067	1	11:10:10.35a.m.	11:10:10.35a.m.	1	1
	2	car	2.468	1	12:57:49.38p.m.	12:57:49.38p.m.	1	1
The vehcile stops at the intersection when the red light is on but after a while when he notices that no vehicle is coming at the intersection he crosses the intersection even on the red light time.								
	2	car	300+	1	2:05:05.21p.m.	2:05:05.21p.m.	1	1
	2	car	1.869	1	3:07:50.85p.m.	3:07:50.85p.m.	1	1
The vehcile stops at the intersection when the red light is on but after a while when he notices that no vehicle is coming at the intersection he crosses the intersection even on the red light time.								
	2	car	300+	1	3:18:25.41p.m.	3:18:25.41p.m.	1	1
	2	car	1.001	1	3:44:31.40p.m.	3:44:31.40p.m.	1	1
	2	car	1.401	1	5:09:31.14p.m.	5:09:31.14p.m.	1	1
	2	car	1.334	1	5:52:50.422p.m.	5:52:50.422p.m.	1	1
	2	car	1.468	1	6:10:11.90p.m.	6:10:11.90p.m.	1	1
Two vehicles violates the redlight time at the sa.m.e time	3	truck	1.001	2	6:34:12.12p.m.	6:34:12.12p.m.	2	3
	2	car	3.063	2	6:34:12.12p.m.	6:34:12.12p.m.	2	3
	2	car	1.335	1	6:43:12.14p.m.	6:43:12.14p.m.	1	1
	2	car	1.401	1	7:10:12.55p.m.	7:10:12.55p.m.	1	1
	2	car	0.334	1	8:56:59.92p.m.	8:56:59.92p.m.	1	1
	3	van	1.535	1	9:41:33.62p.m.	9:41:33.62p.m.	1	1
	2	car	300+	1	10:28:27.40p.m.	10:28:27.40p.m.	1	1

Table A26. Before Study at Intersection of US-69 & 95th Street East (24 hours) 27th August 2014

Comments	Number of vehicle	US69 & 95th (E)						
		Type of vehicle	Seconds into red (sec)	Northbound Approach	Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane				
	2	car	2.876	1	12:49:59.25a.m.	12:49:59.25a.m.	1	1
confused					1:40:36 a.m.			
	2	car	300+	1	4:19:50.21p.m.	4:19:50.21a.m.	1	1
	2	car	3.003	1	5:27:50.31a.m.	5:27:50.31a.m.	1	1
	2	car	1.268	1	5:48:03.78a.m.	5:48:03.78a.m.	1	1
	2	car	3.004	1	6:40:27.65a.m.	6:40:28.65a.m.	1	1
	2	car	1.335	1	6:49:05.93a.m.	6:49:05.93a.m.	1	1
	2	car	1.202	1	7:19:36.40a.m.	7:19:36.40a.m.	1	1
	2	car	1.469	1	7:52:56.18a.m.	7:52:56.18a.m.	1	1
	5	dump truck	1.702	1	8:19:36.30a.m.	8:19:36.30a.m.	1	1
	2	car	2.581	1	8:21:16.34a.m.	8:21:16.34a.m.	1	1
Two vehicles violates the red light time at a	3	truck	1.001	2	8:49:09.22a.m.	8:49:09.22a.m.	2	3
	2	car	2.335	2	8:49:09.22a.m.	8:49:09.22a.m.	2	3
	3	van	2.803	1	8:58:09.22a.m.	8:58:09.22a.m.	1	1
	2	car	2.403	1	9:37:09.58a.m.	9:37:09.58a.m.	1	1
	3	pick up	2.202	1	9:38:39.51a.m.	9:38:39.51a.m.	1	1
Two vehicles violates the red light time at a	2	car	1.601	2	10:25:20.99a.m.	10:25:20.99a.m.	2	3
	2	car	3.069	2	10:25:20.99a.m.	10:25:20.99a.m.	2	3
Driver waited sometime for the green signal but he crosses the intersection even when the red light is indicated.								
	3	van	300+	1	10:27:34a.m.	10:27:34a.m.	1	1
Two vehicles violates the red light time at a time	3	van	2.069	2	11:23:39.53a.m.	11:23:39.53a.m.	2	3
	2	car	2.936	2	11:23:39.53a.m.	11:23:39.53a.m.	2	3
	2	car	1.735	1	11:27:50.18a.m.	11:27:50.18a.m.	1	1
	2	car	1.536	1	3:19:31.785p.m.	3:19:31.785p.m.	1	1
Two vehicles violates the red light time at a	2	car	1.334	2	5:34:32.63p.m.	5:34:32.63p.m.	2	3
	2	car	2.936	2	5:34:32.63p.m.	5:34:32.63p.m.	2	3
Driver waited sometime for the green signal but he crosses the intersection even when the red light is indicated.								
	2	car	300+	1	5:57:02 p.m.	5:57:02 p.m.	1	1
	2	car	1.134	1	6:22:13.73p.m.	6:22:13.73p.m.	1	1
	2	car	0.934	1	7:38:43.147p.m.	7:38:43.147p.m.	1	1

Table A27. Before Study at Intersection of US-69 & 95th Street East (24 hours) 28th August 2014

Comments	Number of vehicle	US69 & 95th (E)						
		Type of vehicle	Seconds into red	Northbound	Time of Day (a.m.)	Time on video	Violations per lane	Violation Configuratio
	Code			Inner Left lane				
Never Stopped	2	car	300+	1	5:47:53.21a.m.	5:47:53.21a.m.	1	1
	2	car	1.134	1	5:50:06.57a.m.	5:50:06.57a.m.	1	1
	2	car	1.001	1	6:50:22.40a.m.	6:50:22.40a.m.	1	1
	3	truck	1.534	1	7:44:37.25a.m.	7:44:37.25a.m.	1	1
	2	car	1.869	1	7:46:17.20a.m.	7:46:17.20a.m.	1	1
	2	car	2.068	1	7:47:57.16a.m.	7:47:57.16a.m.	1	1
	2	car	1.735	1	7:49:37.26a.m.	7:49:37.26a.m.	1	1
	2	car	1.201	1	7:52:57.38a.m.	7:52:57.38a.m.	1	1
	2	car	1.402	1	7:54:37.41a.m.	7:54:37.41a.m.	1	1
	2	car	1.201	1	7:56:17.30a.m.	7:56:17.30a.m.	1	1
	2	car	2.202	1	8:37:10.79a.m.	8:37:10.79a.m.	1	1
	2	car	1.602	1	9:47:41.21a.m.	9:47:41.21a.m.	1	1
	2	car	1.602	1	10:07:11.57a.m.	10:07:11.57a.m.	1	1
	2	car	1.602	1	10:31:11.65a.m.	10:31:11.65a.m.	1	1
	2	car	1.268	1	11:01:11.86a.m.	11:01:11.86a.m.	1	1
	2	car	1.334	1	12:39:30.85p.m.	12:39:30.85p.m.	1	1
	2	car	1.466	1	12:41:10.74p.m.	12:41:10.74p.m.	1	1
	2	car	1.935	1	3:42:53.63p.m.	3:42:53.63p.m.	1	1
	2	car	1.535	1	4:11:07.85p.m.	4:11:07.85p.m.	1	1
Stopped at the intersection but crosses the intersection even on the red light time.	2	car	300+	1	5:10:37.48p.m.	5:10:37.48p.m.	1	1
	2	car	1.268	1	6:02:39.31p.m.	6:02:39.31p.m.	1	1
Two vehicles violates the red light time at the	2	car	2.403	2	6:05:39.70p.m.	6:05:39.70p.m.	2	3
	2	car	4.338	2	6:05:39.70p.m.	6:05:39.70p.m.	2	3
	2	car	1.601	1	6:07:09.26p.m.	6:07:09.26p.m.	1	1
	2	car	2.869	1	6:11:39.27p.m.	6:11:39.27p.m.	1	1
	2	car	2.603	1	6:13:09.23p.m.	6:13:09.23p.m.	1	1
	2	car	1.801	1	6:32:39.37p.m.	6:32:39.37p.m.	1	1
	2	car	1.868	1	6:49:09.33p.m.	6:49:09.33p.m.	1	1

Control Site Volume

I-435 & Antioch North

Table A28. 26th August 2014

Time	Volume	
	Inner	outer
12- 2a.m.	4	5
2- 4 a.m.		
4- 5a.m.		
5- 7a.m.	54	65
7- 9a.m.	218	192
9-12a.m.	183	157
12-2p.m.	120	116
2-4p.m.	155	99
4-6p.m.	126	94
6-8 p.m.	74	69
8-10p.m.	62	58
10-12p.m.	34	35

Table A29. 27th August 2014

Time	Volume	
	Inner	outer
12- 2a.m.	15	9
2- 4 a.m.	3	7
4- 5a.m.	6	5
5- 7a.m.	74	79
7- 9a.m.	189	178
9-12a.m.	171	157
12-2p.m.	122	102
2-4p.m.	161	97
4-6p.m.	134	127
6-8p.m.	121	95
8-10p.m.	76	56
10-12p.m.	32	38

Table A30. 28th August 2014

Time	Volume	
	Inner	outer
12- 2a.m.	9	11
2- 4 a.m.	6	4
4- 5a.m.	4	5
5- 7a.m.	68	75
7- 9a.m.	188	215
9-12a.m.	199	160
12-2p.m.	130	111
2-4p.m.	159	121
4-6p.m.	139	125
6-8p.m.	117	98
8-10p.m.	41	35
10-12p.m.	43	32

I-435 & Antioch South

Table A31. 26th August

Time	Volume	
	Inner	Outer
12-2a.m.	9	8
2-5a.m.	Camera Angle changed	
5-7a.m.		
7-9a.m.	300	294
9-12p.m.	477	400
12-2p.m.	400	334
2-4p.m.	432	335
4-6p.m.	917	811
6-8P.m.	316	256
8-10p.m.	162	107
10-12a.m.	65	46

Table A32. 27th August 2014

Time	Volume	
	Inner	Outer
12-2a.m.	20	14
2-5a.m.	16	8
5-7a.m.	87	84
7-9a.m.	353	314
9-12p.m.	491	377
12-2p.m.	349	284
2-4p.m.	439	346
4-6p.m.	924	768
6-8P.m.	296	253
8-10p.m.	132	101
10-12a.m.	58	46

Table A33. 28th August 2014

Time	Volume	
	Inner	Outer
12-2a.m.	22	8
2-4a.m.	15	7
4-7A.m.	85	83
7-9a.m.	355	293
9-12p.m.	473	395
12-12:20	159	130
12:20-2p.m.	Ca.m.era Angle Changed	
3:15-4p.m.	53	29
4-6p.m.	950	793
6-8P.m.	280	263
8-10p.m.	161	136
10-12a.m.	44	45

I-435 & Metcalf Avenue North

Table A34. 26th August 2014

Time	Volume	
	Inner	Outer
12-2a.m.	89	30
2-5a.m.	21	12
5-7a.m.	89	42
7-9a.m.	354	181
9-12p.m.	725	341
12-2p.m.	542	233
2-4p.m.	792	332
4-6p.m.	1153	560
6-8P.m.	576	272
8-10p.m.	340	182
10-12a.m.	178	78

Table A35. 27th August 2014

Time	Volume	
	Inner	Outer
0:12:25	31	10
12:25-6a.m.	Camera Angle Changed	
6-7a.m.	101	37
7-9a.m.	352	204
9-12p.m.	703	366
12-2p.m.	626	323
2-3:30p.m.	463	216
3:30-6p.m.	Camera Angle Changed	
6-8P.m.		
8-10p.m.		
10-12a.m.		

Table A36. 28th August 2014

Time	Volume	
	Inner	Outer
12-2a.m.		
2-5a.m.		
6-7a.m.	86	30
7-9a.m.	352	210
9-12p.m.	995	528
12-2p.m.	631	333
2-4p.m.	800	361
4-6p.m.	1117	516
6-8P.m.	535	258
8-10p.m.	332	175
10-12a.m.	186	88

US-69 & 95th Street West

Table A37. 26th August 2014

Time	volume
12- 2a.m.	13
2- 4 a.m.	10
4 to 4 40	2
4 40 to 6 camera disturbed	
6- 7a.m.	65
7- 9a.m.	150
9-12a.m.	197
12-2p.m.	203
2-4p.m.	229
4-6p.m.	238
6-8p.m.	206
8-10p.m.	211
10-12p.m.	44

Table A38. 27th August 2014

Time	volume
12- 2a.m.	12
2- 4 a.m.	8
4- 5a.m.	7
5- 7a.m.	73
7- 9a.m.	197
9-12a.m.	197
12-2p.m.	212
2-4p.m.	232
4-6p.m.	261
6-8p.m.	209
8-10p.m.	183
10-12p.m.	41

Table A39. 28th August 2014

Time	volume
12- 2a.m.	12
2- 4 a.m.	8
4- 5a.m.	7
5- 7a.m.	85
7- 9a.m.	212
9-12a.m.	196
12-2p.m.	228
2-4p.m.	210
4-6p.m.	245
6-8p.m.	222
8-10p.m.	220
10-12p.m.	60

US-69 & 95th Street East

Table A40. 26th August 2014

Time	volume
12- 2a.m.	18
2- 4 a.m.	10
4- 5a.m.	14
5- 7a.m.	220
7- 9a.m.	630
9-12a.m.	383
12-2p.m.	326
2-4p.m.	337
4-6p.m.	429
6-8p.m.	302
8-10p.m.	176
10-12p.m.	81

Table A41. 27th August 2014

Time	Volume
12- 2a.m.	16
2- 4 a.m.	8
4- 5a.m.	11
5- 7a.m.	190
7- 9a.m.	625
9-12a.m.	421
12-2p.m.	314
2-4p.m.	353
4-6p.m.	416
6-8p.m.	337
8-10p.m.	181
10-12p.m.	81

Table A42. 28th August 2014

Time	Volume
12- 2a.m.	22
2- 4 a.m.	9
4- 5a.m.	11
5- 7a.m.	194
7- 9a.m.	605
9-12a.m.	414
12-2p.m.	337
2-4p.m.	347
4-6p.m.	437
6-8p.m.	320
8-10p.m.	158
10-12p.m.	80

ONE MONTH AFTER STUDY RLR VIOLATIONS

Treatment Sites

Table A43. One Month After Study at Intersection of I-435 & Quivera North (24 hours) 14th October 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Quivera N							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configuration
	Code			Inner Left lane	Outer left lane				
	3	Pick Up	1.9	1		9:56:14.916a.m.	9:56:14.916a.m.	1	1
	2	Passenger Car	2.1	1		10:09:35.087a.m.	10:09:35.087a.m.	1	1
	2	Passenger Car	1.1	1		9:06:58.955p.m.	9:06:58.955p.m.	1	1

Table A44. One Month After Study at Intersection of I-435 & Quivera North (24 hours) 15th October 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Quivera							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
didnt even stop	2	Passenger Car	51.2	1		4:39:00.439a.m.	4:39:00.439a.m.	1	1
	2	Passenger Car	106	1		5:45:37.999a.m.	5:45:37.999a.m.	1	1
	2	Passenger Car	3.5		1	7:24:51.064a.m.	7:24:51.064a.m.	1	1
	2	Passenger Car	4.1		1	7:42:50.649a.m.	7:42:50.649a.m.	1	1

Table A45. One Month After Study at Intersection of I-435 & Quivera North (24 hours) 16th October 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Quivera							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	106		1	4:28:20.596a.m.	4:28:20.596a.m.	1	1
	2	Passenger Car	2.4		1	12:23:43.490p.m.	12:23:43.490p.m.	1	1
	2	Passenger Car	1.2	1		1:15:18.845p.m.	1:15:18.845p.m.	1	1
	2	Passenger Car	2.3		1	5:47:03.755p.m.	5:47:03.755p.m.	1	1

Table A46. One Month After Study at Intersection of I-435 & Quivera South (24 hours) 14th October 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Quivera S							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	90	1		12:39:38.913a.m.	12:39:38.913a.m.	1	1
	2	Passenger Car	52	1		1:32:59.480a.m.	1:32:59.480a.m.	1	1
	2	Passenger Car	13.1	1		4:42:22.696a.m.	4:42:22.696a.m.	1	1
	2	Passenger Car	19.2		1	4:49:01.312a.m.	4:49:01.312a.m.	1	1
	2	Passenger Car	8.6	1		5:01:02.072a.m.	5:01:02.072a.m.	1	1
	2	Passenger Car	2.5	1		6:42:12.534a.m.	6:42:12.534a.m.	1	1
	2	Passenger Car	2.9		1	7:40:17.377a.m.	7:40:17.377a.m.	1	1
	2	Passenger Car	4.5		1	7:42:17.246a.m.	7:42:17.246a.m.	1	1
Ran Together	2	Passenger Car	2.4	1		9:02:15.899a.m.	9:02:15.899a.m.	2	3
	2	Passenger Car	2.4	1		9:02:15.899a.m.	9:02:15.899a.m.	2	3
	2	Passenger Car	2.4	1		9:12:15.791a.m.	9:12:15.791a.m.	1	1
	2	Passenger Car	6.6	1		9:30:35.364a.m.	9:30:35.364a.m.	1	1
	2	Passenger Car	2.1		1	10:52:14.555a.m.	10:52:14.555a.m.	1	1
	2	Passenger Car	3		1	12:27:09.843a.m.	12:27:09.843a.m.	1	1
	2	Passenger Car	2.1	1		12:31:10.118a.m.	12:31:10.118a.m.	1	1
	2	Passenger Car	2.8		1	2:15:08.493p.m.	2:15:08.493p.m.	1	1
	2	Passenger Car	3.8	1		3:31:10.867p.m.	3:31:10.867p.m.	1	1
	2	Passenger Car	2	1		4:41:07.896p.m.	4:41:07.896p.m.	1	1
	3	Pick-up Trcuk	4.7		1	5:22:59.389p.m.	5:22:59.389p.m.	1	1
	3	Pick-up Trcuk	2.4		1	5:25:27.996p.m.	5:25:27.996p.m.	1	1
	3	Pick-up Trcuk	2.4		1	5:30:08.273p.m.	5:30:08.273p.m.	1	1
	2	Passenger Car	3.5	1		6:51:10.791p.m.	6:51:10.791p.m.	1	1

Table A47. One Month After Study at Intersection of I-435 & Quivera South (24 hours) 15th October 2014

Number of vehicle	I-435 & Quivera S							
	Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
Code			Inner Left lane	Outer left lane				
2	Passenger Car	16.5	1		4:51:26.524a.m.	4:51:26.524a.m.	1	1
2	Passenger Car	1.8	1		3:02:52.540p.m.	3:02:52.540p.m.	1	1
2	Passenger Car	3.8	1		3:38:51.492p.m.	3:38:51.492p.m.	1	1
2	Passenger Car	3	1		3:58:51.522p.m.	3:58:51.522p.m.	1	2
2	Passenger Car	4		1	3:58:51.522p.m.	3:58:51.522p.m.	1	2
2	Passenger Car	3	1		6:24:54.428p.m.	6:24:54.428p.m.	1	1
2	Passenger Car	2.5		1	6:48:54.083p.m.	6:48:54.083p.m.	1	1
2	Passenger Car	2.5	1		6:52:53.934p.m.	6:52:53.934p.m.	1	1

Table A48. One Month After Study at Intersection of I-435 & Quivera South (24 hours) 16th October 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Quivera S							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	32.6	1		4:50:07.158a.m.	4:50:07.158a.m.	1	1
	2	Passenger Car	21	1		5:55:30.423a.m.	5:55:30.423a.m.	1	1
	2	Passenger Car	2.2		1	6:56:57.892a.m.	6:56:57.892a.m.	1	1
	2	Passenger Car	2.6	1		7:01:57.477a.m.	7:01:57.477a.m.	1	1
	2	Passenger Car	3.6		1	7:12:01.212a.m.	7:12:01.212a.m.	1	1
	2	Passenger Car	2.6	1		7:38:02.923a.m.	7:38:02.923a.m.	1	1
	2	Passenger Car	2.5	1		8:46:59.822a.m.	8:46:59.822a.m.	1	1
Didn't even stop	2	Passenger Car	15.6	1		9:02:00.073a.m.	9:02:00.073a.m.	1	1
	2	Passenger Car	2.4	1		9:18:39.432a.m.	9:18:39.432a.m.	1	1
	2	Passenger Car	2.3	1		2:20:27.203p.m.	2:20:27.203p.m.	1	1
	2	Passenger Car	3	1		3:06:26.986p.m.	3:06:26.986p.m.	1	1
	2	Passenger Car	2.4	1		3:46:26.403p.m.	3:46:26.403p.m.	1	1
	2	Passenger Car	2		1	5:03:58.931p.m.	5:03:58.931p.m.	1	1
	2	Passenger Car	2.1	1		5:58:07.704p.m.	5:58:07.704p.m.	1	1

Volumes

Treatment Site

I-435 & Quivera North

Table A48. 14th October 2014

Time	Volume	
	Inner	Outer
12-6a.m.	Camera Angle Changed	
6-7a.m.	86	29
7-9a.m.	386	258
9-12p.m.	474	311
12-2p.m.	353	201
2-4p.m.	473	253
4-6p.m.	442	324
6-8P.m.	274	193
8-10p.m.	154	81
10-12a.m.	58	26

Table A49. 15th October 2014

Time	Volume	
	Inner	Outer
12-2a.m.	13	7
2-5a.m.	24	10
5-7a.m.	125	42
7-9a.m.	347	218
9-12p.m.	419	267
12-2p.m.	405	252
2-4p.m.	453	243
4-4:40p.m.	119	78
6-8P.m.	260	161
8-10p.m.	141	82
10-12a.m.	46	30

Table A50. 16th October 2014

Time	Volume	
	Inner	Outer
12-2a.m.	19	13
2-5a.m.	28	11
5-7a.m.	112	49
7-9a.m.	489	360
9-12p.m.	426	279
12-2p.m.	378	223
2-4p.m.	429	277
4-6p.m.	380	252
6-8P.m.	273	160
8-10p.m.	146	89
10-12a.m.	61	31

I-435 & Quivera South

Table A51. 14th October 2014

Time	Volume	
	Inner	Outer
12-2a.m.	21	10
2-5a.m.	40	24
5-7a.m.	310	190
7-9a.m.	871	639
9-12p.m.	779	501
12-2p.m.	497	332
2-4p.m.	755	501
4-6p.m.	787	610
6-8P.m.	589	437
8-10p.m.	415	338
10-12a.m.	146	106

Table A52. 15th October 2014

Time	Volume	
	Inner	Outer
12-2a.m.	35	31
2-5a.m.	61	36
5-7a.m.	381	224
7-8a.m.	503	370
8-2p.m.	Camera Angle Changed	
2-4p.m.	715	507
4-4:40p.m.	265	172
4:40-6p.m.	Camera Angle changed	
6-8P.m.	558	429
8-10p.m.	375	293
10-12a.m.	112	84

Table A53. 16th October 2014

Time	Volume	
	Inner	Outer
12-2a.m.	41	30
2-5a.m.	54	28
5-7a.m.	323	179
7-9a.m.	940	704
9-12p.m.	927	671
12-2p.m.	435	309
2-4p.m.	629	507
4-6p.m.	665	536
6-8P.m.	598	445
8-10p.m.	430	328
10-12a.m.	91	73

CONTROL SITES

Table A54. One Month After Study at Intersection of I-435 & Antioch North (24 hours) 14th October 2014

Any Comment or Confusion mention here.	Number of vehicle	Na.m.e of Intersection							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configuration
	Code			Inner Left lane	Outer left lane				
	2	passender car	2	1		12:39:49 p.m.	1:39:49 p.m.	1	1
	2	passender car	2		1	2:04:19 p.m.	3:04:19 p.m.	1	1
	2	passender car	3	1		2:32:42 p.m.	3:32:42 p.m.	1	2
	3	pick up	3		1	2:32:42 p.m.	3:32:42 p.m.	1	2
	2	passender car	2	1		3:10:53 p.m.	4:10:53 p.m.	1	2
	3	van	2		1	3:10:53 p.m.	4:10:53 p.m.	1	2
	2	passender car	1		1	3:19:15 p.m.	4:19:15 p.m.	1	1
	2	passender car	2	1		6:38:18 p.m.	7:38:18 p.m.	1	1
	3	van	2	1		10:07:43 p.m.	11:07:43 p.m.	1	1

Table A55. One Month After Study at Intersection of I-435 & Antioch North (24 hours) 16th October 2014

Any Comment or Confusion mention here.	Number of vehicle	Na.m.e of Intersection							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	34.1		1	9:20:30.811a.m.	9:20:30.811a.m.	1	1
	2	Passenger Car	2		1	9:41:23.424a.m.	9:41:23.424a.m.	1	1
	2	Passenger Car	1.8		1	9:44:28.411a.m.	9:44:28.411a.m.	1	1
	2	Passenger Car	35.2		1	9:20:29.612a.m.	9:20:29.612a.m.	1	1
	2	Passenger Car	2	1		9:35:24.979a.m.	9:35:24.979a.m.	1	1
	2	Passenger Car	2.4		1	9:41:23.424a.m.	9:41:23.424a.m.	1	1
	2	Passenger Car	2.5	1		10:29:25.340a.m.	10:29:25.340a.m.	1	1
	2	Passenger Car	1.8	1		10:55:03.504a.m.	10:55:03.504a.m.	1	1
	2	Passenger Car	2	1		11:39:40.004a.m.	11:39:40.004a.m.	1	1
	2	Passenger Car	2.2	1		1:15:31.095p.m.	1:15:31.095p.m.	1	1
	2	Passenger Car	1.4	1		1:49:45.796p.m.	1:49:45.796p.m.	1	1
	2	Passenger Car	1.8	1		1:59:39.019p.m.	1:59:39.019p.m.	1	1
	2	Passenger Car	2.2		1	2:38:05.806p.m.	2:38:05.806p.m.	1	1

Table A56. One Month After Study at Intersection of I-435 & Antioch North (24 hours) 15th October 2014

Any Comment or Confusion mention here.	Number of vehicle	Antioch north 10/14							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	3	van	0.01	1		6:34:09 a.m.	6:34:09 a.m.	1	1
	2	passengar car	2	1		7:01:18 a.m.	7:01:18 a.m.	1	1
		passengar car	4	1		13:23:10 p.m.	13:23:10 p.m.	1	1
		passengar car	1		1	14:04:58 p.m.	14:04:58 p.m.	1	1
		pick up	0.02		1	14:08:18 p.m.	14:08:18 p.m.	1	
		passengar car	4	1		14:38:16 p.m.	14:38:16 p.m.	1	1
		passengar car	0.01	1		15:15:20 p.m.	15:15:20 p.m.	1	1

Table A57. One Month After Study at Intersection of I-435 & Antioch South (24 hours) 14th October 2014

Any Comment or Confusion mention here.	Number of vehicle	Antioch South							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	5	Truck	2.2	1		7:23:23.118a.m.	7:23:23.118a.m.	1	1
	5	Truck	3.3		1	7:43:22.785a.m.	7:43:22.785a.m.	1	1
	2	Passenger Car	2.2	1		9:05:02.929a.m.	9:05:02.929a.m.	1	1
	2	Passenger Car	2.9	1		9:14:02.947a.m.	9:14:02.947a.m.	1	1
	3	Pick Up truck	2.2	1		9:17:02.783a.m.	9:17:02.783a.m.	1	1
	2	Passenger Car	3.2	1		9:26:03.037a.m.	9:26:03.037a.m.	1	1
	2	Passenger Car	3		1	9:33:33.291a.m.	9:33:33.291a.m.	1	1
	2	Passenger Car	3.4	1		11:02:28.808a.m.	11:02:28.808a.m.	1	1
	2	Passenger Car	2.2		1	11:20:54.679a.m.	11:20:54.679a.m.	1	1
	2	Passenger Car	6.2		1	12:52:42.852p.m.	12:52:42.852p.m.	1	1
	2	Passenger Car	2.6		1	2:32:34.293p.m.	2:32:34.293p.m.	1	1
	2	Passenger Car	2.5	1		3:25:56.919p.m.	3:25:56.919p.m.	1	1
	2	Passenger Car	3.1		1	3:35:56.972p.m.	3:35:56.972p.m.	1	1
	2	Passenger Car	3.2		1	3:50:53.323p.m.	3:50:53.323p.m.	1	1
	2	Passenger Car	3.7		1	3:53:13.831p.m.	3:53:13.831p.m.	1	1
	2	Passenger Car	2.7	1		4:48:53.190p.m.	4:48:53.190p.m.	1	1
	2	Passenger Car	2.8	1		4:58:12.566p.m.	4:58:12.566p.m.	1	1
	2	Passenger Car	3.3	1		5:05:12.731p.m.	5:05:12.731p.m.	1	1
	2	Passenger Car	3.5		1	5:09:51.796p.m.	5:09:51.796p.m.	2	3
	2	Passenger Car	4.5		1	5:09:51.796p.m.	5:09:51.796p.m.	2	3
	2	Passenger Car	3.2		1	5:23:52.258p.m.	5:23:52.258p.m.	1	1
	2	Passenger Car	2.4	1		6:07:22.826p.m.	6:07:22.826p.m.	1	2
Ran Together	2	Passenger Car	2.4		1	6:07:22.826p.m.	6:07:22.826p.m.	1	2
	2	Passenger Car	4.6	1		6:07:22.826p.m.	6:07:22.826p.m.	1	1
	2	Passenger Car	2.1		1	6:27:37.337p.m.	6:27:37.337p.m.	1	1
	2	Passenger Car	2.3		1	7:00:40.340p.m.	7:00:40.340p.m.	1	2
	2	Passenger Car	2.3	1		7:00:40.340p.m.	7:00:40.340p.m.	1	2
	2	Passenger Car	2.8	1		7:07:41.657p.m.	7:07:41.657p.m.	1	1

Table A58. One Month After Study at Intersection of I-435 & Antioch South (24 hours) 15th October 2014

Any Comment or Confusion mention here.	Number of vehicle	Na.m.e of Intersection							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	2.1	1		6:14:29.088a.m.	6:14:29.088a.m.	1	1
	2	Passenger Car	2.4	1		7:07:47.797a.m.	7:07:47.797a.m.	1	1
	2	Passenger Car	2.8	1		7:10:41.506a.m.	7:10:41.506a.m.	1	1
	2	Passenger Car	2	1		10:06:18.407a.m.	10:06:18.407a.m.	1	1
	2	Passenger Car	2.6		1	1:42:18.889p.m.	1:42:18.889p.m.	1	1
	2	Passenger Car	2.2		1	4:43:16.712p.m.	4:43:16.712p.m.	1	1
	2	Passenger Car	2.5		1	5:11:56.404p.m.	5:11:56.404p.m.	1	1
	2	Passenger Car	1.8	1		5:18:59.918p.m.	5:18:59.918p.m.	1	1
	2	Passenger Car	3.2	1		6:25:39.843p.m.	6:25:39.843p.m.	1	1
	2	Passenger Car	2.5	1		6:33:59.885p.m.	6:33:59.885p.m.	1	1
	2	Passenger Car	2.5	1		7:12:11.478p.m.	7:12:11.478p.m.	1	1

Table A59. One Month After Study at Intersection of I-435 & Antioch South (24 hours) 16th October 2014

Any Comment or Confusion mention here.	Number of vehicle	Antioch S							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	2.5	1		6:14:35.467a.m.	6:14:35.467a.m.	1	1
	2	Passenger Car	2.8		1	7:03:20.587a.m.	7:03:20.587a.m.	1	1
	2	Passenger Car	2.4	1		9:49:51.051a.m.	9:49:51.051a.m.	1	1
	2	Passenger Car	2.2	1		10:00:21.278a.m.	10:00:21.278a.m.	1	1
	2	Passenger Car	2.4	1		2:30:17.809p.m.	2:30:17.809p.m.	1	1
	2	Passenger Car	2.6	1		3:08:40.308p.m.	3:08:40.308p.m.	1	1
	2	Passenger Car	1.9	1		3:54:44.761p.m.	3:54:44.761p.m.	1	1
	2	Passenger Car	2.6		1	5:04:46.934p.m.	5:04:46.934p.m.	1	1
	2	Passenger Car	2.8		1	5:07:06.875p.m.	5:07:06.875p.m.	1	1
	2	Passenger Car	1.9	1		5:09:26.797p.m.	5:09:26.797p.m.	1	2
Ran Together	2	Passenger Car	19		1	5:09:26.797p.m.	5:09:26.797p.m.	1	2
	2	Passenger Car	3.9		1	5:09:26.797p.m.	5:09:26.797p.m.	1	1
	2	Passenger Car	3.3	1		5:21:06.798p.m.	5:21:06.798p.m.	1	1
	2	Passenger Car	3.2	1		5:26:03.059p.m.	5:26:03.059p.m.	1	1
	2	Passenger Car	1.8	1		6:25:59.889p.m.	6:25:59.889p.m.	1	1

Table A60. One Month After Study at Intersection of I-435 & Metcalf Avenue North (24 hours) 14th October 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 and Metcalf							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	0.9	1		9:52:02.626a.m.	9:52:02.626a.m.	1	1
	2	Passenger Car	2.7	1		10:06:16.661a.m.	10:06:16.661a.m.	1	1
	2	Passenger Car	2.1	1		10:35:12.570a.m.	10:35:12.570a.m.	1	1
	2	Passenger Car	2.1	1		10:41:26.547a.m.	10:41:26.547a.m.	1	1
	2	Passenger Car	2.6		1	10:57:31.741a.m.	10:57:31.741a.m.	1	1
	2	Passenger Car	1.7	1		1:02:21.439p.m.	1:02:21.439p.m.	1	1
	2	Passenger Car	2.4	1		1:25:26.914p.m.	1:25:26.914p.m.	1	1
	2	Passenger Car	2.4		1	2:09:32.961p.m.	2:09:32.961p.m.	1	1
	2	Passenger Car	1.9	1		2:13:44.835p.m.	2:13:44.835p.m.	1	1
	2	Passenger Car	2.6	1		2:49:26.700p.m.	2:49:26.700p.m.	1	1
	2	Passenger Car	3		1	3:08:20.808p.m.	3:08:20.808p.m.	1	1
	1	Motorcycle	1.4	1		3:14:38.692p.m.	3:14:38.692p.m.	1	1
	2	Passenger Car	2.5	1		3:16:44.883p.m.	3:16:44.883p.m.	1	1
	2	Passenger Car	5.1	1		3:37:44.998p.m.	3:37:44.998p.m.	1	1
	2	Passenger Car	2.1	1		3:41:57.197p.m.	3:41:57.197p.m.	1	1
	2	Passenger Car	1.7	1		5:25:17.588p.m.	5:25:17.588p.m.	1	1
	2	Passenger Car	2	1		5:50:57.570p.m.	5:50:57.570p.m.	1	1
	2	Passenger Car	2	1		6:23:38.281p.m.	6:23:38.281p.m.	1	1
	2	Passenger Car	2.7		1	6:32:03.230p.m.	6:32:03.230p.m.	1	1
	2	Passenger Car	2.8		1	6:34:09.313p.m.	6:34:09.313p.m.	1	1
	2	Passenger Car	2.3	1		7:07:45.428p.m.	7:07:45.428p.m.	1	1

Table A61. One Month After Study at Intersection of I-435 & Metcalf Avenue North (24 hours) 15th October 2014

Any Comment or Confusion mention here.	Number of vehicle	Type of vehicle	I-435 and Metcalf						
			Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	29.09	1		4:39:24.236a.m.	4:39:24.236a.m.	1	1
	2	Passenger Car	2.1		1	7:10:32.139a.m.	7:10:32.139a.m.	1	1
Ran together	2	Passenger Car	3.1	1		7:17:56.102a.m.	7:17:56.102a.m.	2	3
	2	Passenger Car	3.9	1		7:17:56.102a.m.	7:17:56.102a.m.	2	3
	2	Passenger Car	3.2		1	7:22:36.501a.m.	7:22:36.501a.m.	1	1
	2	Passenger Car	2.5	1		7:41:16.283a.m.	7:41:16.283a.m.	1	1
	2	Passenger Car	3.3		1	7:50:35.939a.m.	7:50:35.939a.m.	1	1
	2	Passenger Car	2.5	1		7:55:15.903a.m.	7:55:15.903a.m.	1	1
	2	Passenger Car	2.3	1		8:04:36.054a.m.	8:04:36.054a.m.	1	1
	2	Passenger Car	2.3	1		8:11:36.234a.m.	8:11:36.234a.m.	1	1
	3	Pick up	2.3	1		8:46:36.560a.m.	8:46:36.560a.m.	1	1
	2	Passenger Car	2.8	1		8:55:56.998a.m.	8:55:56.998a.m.	1	1
	3	Pick up	2		1	9:30:51.612a.m.	9:30:51.612a.m.	1	1
Ran Together	2	Passenger Car	1.1		1	9:40:34.753a.m.	9:40:34.753a.m.	2	3
	2	Passenger Car	1.2		1	9:40:34.753a.m.	9:40:34.753a.m.	2	3
	2	Passenger Car	2	1		11:29:41.359a.m.	11:29:41.359a.m.	1	1
	2	Passenger Car	2.5	1		1:02:05.282p.m.	1:02:05.282p.m.	1	1
	2	Passenger Car	2.3	1		1:06:17.363p.m.	1:06:17.363p.m.	1	1
	2	Passenger Car	0.9	1		2:02:59.085p.m.	2:02:59.085p.m.	1	1
	3	Pick up	1.9	1		2:34:29.184p.m.	2:34:29.184p.m.	1	1
	2	Passenger Car	2.3	1		2:57:34.938p.m.	2:57:34.938p.m.	1	1
	2	Passenger Car	2.9		1	4:03:21.907p.m.	4:03:21.907p.m.	1	1
	2	Passenger Car	2.9		1	4:12:42.146p.m.	4:12:42.146p.m.	1	1
	2	Passenger Car	1.9		1	4:15:02.185p.m.	4:15:02.185p.m.	2	3
	2	Passenger Car	3.6		1	4:15:02.185p.m.	4:15:02.185p.m.	2	3
	2	Passenger Car	2.6	1		4:45:22.485p.m.	4:45:22.485p.m.	1	1
	2	Passenger Car	2.9		1	4:54:41.900p.m.	4:54:41.900p.m.	1	1

Table A62. One Month After Study at Intersection of I-435 & Metcalf Avenue North (24 hours) 16th October 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 and Metcalf							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	5	Truck	2.3		1	6:58:48.799a.m.	6:58:48.799a.m.	1	1
	2	Passenger Car	2.4	1		7:27:19.138a.m.	7:27:19.138a.m.	1	1
	2	Passenger Car	2.5		1	7:45:59.340a.m.	7:45:59.340a.m.		1
	2	Passenger Car	2.9		1	7:48:19.328a.m.	7:48:19.328a.m.	1	1
	2	Passenger Car	2.1	1		8:09:19.562a.m.	8:09:19.562a.m.	1	1
	2	Passenger Car	2.3	1		8:18:39.435a.m.	8:18:39.435a.m.	1	1
	2	Passenger Car	2.3	1		8:23:19.282a.m.	8:23:19.282a.m.	1	1
	2	Passenger Car	2.6		1	8:46:39.178a.m.	8:46:39.178a.m.	1	1
	3	Pick Up	1.6	1		11:17:08.294a.m.	11:17:08.294a.m.	1	1
	2	Passenger Car	1.4	1		12:37:03.370a.m.	12:37:03.370a.m.	1	1
	2	Passenger Car	3	1		1:03:48.057a.m.	1:03:48.057a.m.	1	1
	2	Passenger Car	2.2	1		1:18:30.131p.m.	1:18:30.131p.m.	1	1
	2	Passenger Car	2	1		2:29:19.091p.m.	2:29:19.091p.m.	1	1
	2	Passenger Car	2.2		1	3:01:25.572p.m.	3:01:25.572p.m.	1	1
	2	Passenger Car	2.9		1	4:52:12.466p.m.	4:52:12.466p.m.	1	1
	2	Passenger Car	2.4		1	5:32:18.070p.m.	5:32:18.070p.m.	1	1
	3	Van	3.1	1		5:37:01.453p.m.	5:37:01.453p.m.	1	1
	2	Passenger Car	2.6	1		5:44:00.860p.m.	5:44:00.860p.m.	1	1

Table A65. One Month After Study at Intersection of US-69 & 95th Street West (24 hours) 14th October 2014

Comments	Number of vehicle	US69 & 95th(W)						
		Type of vehicle	Seconds into red	Northbound Approach	Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane				
doesn't stop	2	car	300+	1	5:27:14.25a.m.	2:29:27.85a.m.	1	1
	2	car	300+	1	11:09:12.21a.m.	4:30:52.40a.m.	1	1
	2	car	300+	1	1:02:76.08p.m.	4:37:50.36a.m.	1	1
	2	car	1.935	1	1:38:30.88p.m.	6:03:16.92a.m.	1	1
	2	car	1.868	1	3:03:27.20p.m.	6:28:25.33a.m.	1	1
	2	car	1.871	1	3:09:51.59p.m.	6:37:48.82a.m.	1	1
	2	car	1.469	1	5:25:26.51p.m.	6:38:17.05a.m.	1	1
	2	car	2.702	1	6:30:20.25p.m.	6:51:56.19a.m.	1	1

Table A66. One Month After Study at Intersection of US-69 & 95th Street West (24 hours) 15th October 2014

Comments	Number of vehicle	US69 & 95th (W)						
		Type of vehicle	Seconds into red (sec)	Northbound Approach	Time of Day (a.m.)	Time on video	Violations per lane	Violation Configuration
	Code			Inner Left lane				
Never Stopped	2	car	300+	1	4:44:13.61a.m.	4:44:13.61a.m.	1	1
Never Stopped	2	car	300+	1	4:36:11.38a.m.	4:36:11.38a.m.	1	1
Never Stopped	5	Big truck	300+	1	7:05:49.08a.m.	7:05:49.08a.m.	1	1
	2	car	1.399	1	12:28:20.15p.m.	12:28:20.15p.m.	1	1
	2	car	300+	1	1:48:52.50p.m.	1:48:52.50p.m.	1	1
	1	motor cycle	300+	1	2:40:87.19p.m.	2:40:87.19p.m.	1	1
	2	car	2.269	1	2:42:58.01p.m.	2:42:58.01p.m.	1	1
Car waits and doesn't stop	2	car	300+	1	4:18:42.92p.m.	4:18:42.92p.m.	1	1
	2	car	300+	1	4:48:21.40p.m.	4:48:21.40p.m.	1	1
	2	car	1.535	1	4:51:18.05p.m.	4:51:18.05p.m.	1	1
	2	car	300+	1	5:23:09.58p.m.	5:23:09.58p.m.	1	1
Doesn't wait for the signal	2	car	300+	1	10:29:41.48p.m.	10:29:41.48p.m.	1	1
	2	car	1.735	1	06:52:14.70p.m.	06:52:14.70p.m.	1	1
	2	car	2.069	1	06:58:14.70p.m.	06:58:14.70p.m.	1	1
	2	car	1.268	1	6:02:39.31p.m.	6:02:39.31p.m.	1	1
	2	car	1.468	1	09:51:11.91p.m.	09:51:11.91p.m.	1	1
	2	car	1.162	1	10:18:00.44p.m.	10:18:00.44p.m.	1	1

Table A67. One Month After Study at Intersection of US-69 & 95th Street West (24 hours) 16th October 2014

Comments	Number of vehicle	US69 & 95th (W)						
		Type of vehicle	Seconds into red (sec)	Northbound Approach	Time of Day (a.m.)	Time on video	Violations per lane	Violation Configuration
	Code			Inner Left lane				
doesn't stop	2	car	300+	1	8:58:20.21a.m.	2:29:27.85a.m.	1	1
doesn't stop	2	car	300+	1	9:10:19.39a.m.	4:30:52.40a.m.	1	1
doesn't stop	2	car	300+	1	9:26:54.33a.m.	4:37:50.36a.m.	1	1
doesn't stop	2	car	300+	1	9:37:31.17a.m.	6:03:16.92a.m.	1	1
doesn't stop	2	car	300+	1	10:00:08.57a.m.	6:28:25.33a.m.	1	1
doesn't stop	2	car	300+	1	10:30:23.40a.m.	6:37:48.82a.m.	1	1
	2	car	1.601	1	12:40:02.05p.m.	6:38:17.05a.m.	1	1
	2	car	1.201	1	1:11:03.76p.m.	6:51:56.19a.m.	1	1
	2	car	300+	1	1:19:24.65p.m.	1:19:24.65p.m.	1	1
	2	car	1.335	1	2:16:13.54p.m.	2:16:13.54p.m.	1	1
	2	car	300+	1	2:49:31.782p.m.	2:49:31.782p.m.	1	1
	2	car	1.468	1	4:09:15.36p.m.	4:09:15.36p.m.	1	1
pick up truck and car waits and goes at the sa.m.e time	3 2	Pick up truck car	300+ 300+	2 2	5:13:24.58p.m. 5:13:26.92p.m.	5:13:24.58p.m. 5:13:26.92p.m.	2 2	3 3
	2	car	1.268	1	5:46:50.66p.m.	5:46:50.66p.m.	1	1
	2	car	1.201	1	5:53:24.57p.m.	5:53:24.57p.m.	1	1
	2	car	2.002	1	7:07:53.70p.m.	7:07:53.70p.m.	1	1
	2	car	300+	1	10:12:45.70p.m.	10:12:45.70p.m.	1	1
Car waits and goes	2	car	300+	1	11:38:16.13p.m.	11:38:16.13p.m.	1	1

Table A68. One Month After Study at Intersection of US-69 & 95th Street East (24 hours) 14th October 2014

Comments	Number of vehicle	US69 & 95th(E)						
		Type of vehicle	Seconds into red	Northbound Approach	Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane				
Never Stopped	2	car	300+	1	04:37:07.47a.m.	4:37:07.47a.m.	1	1
	2	car	4.204	1	06:46:25.73a.m.	6:46:25.73a.m.	1	1
	2	car	0.535	1	07:41:20.13a.m.	7:41:20.13a.m.	1	1
	2	car	1.535	1	08:09:39.75a.m.	8:09:39.75a.m.	1	1
	2	car	1.369	1	09:02:43.37a.m.	9:02:43.37a.m.	1	1
	2	car	1.335	1	09:29:43.11a.m.	9:29:43.11a.m.	1	1
U turn Car doesn't stop	2	car	300+	1	10:16:58.24a.m.	10:16:58.24a.m.	1	1
	3	pick up truck	3.296	1	10:28:15.00a.m.	10:28:15.00a.m.	1	1
	5	truck	300+	1	11.03.24.71a.m.	11.03.24.71a.m.	1	1
	3	pick up truck	2.602	1	01:19:32.89a.m.	01:19:32.89a.m.	1	1
	2	car	1.601	1	03:04:31.67p.m.	3:04:31.67a.m.	1	1
	2	car	300+	1	04:10:27.46p.m.	04:10:27.46p.m.	1	1
	3	van	1.002	1	04:16:12.12p.m.	04:16:12.12p.m.	1	1
	2	car	1.401	1	04:42:51.25p.m.	04:42:51.25p.m.	1	1
	2	car	2.002	1	06:02:44.12p.m.	06:02:44.12p.m.	1	1
	2	car	1.602	1	06:07:13.80p.m.	06:07:13.80p.m.	1	1
	2	car	2.738	1	06:11:45.02p.m.	06:11:45.02p.m.	1	1
	2	car	1.802	1	06:28:14.37p.m.	06:28:14.37p.m.	1	1
	2	car	1.735	1	06:52:14.70p.m.	06:52:14.70p.m.	1	1
	2	car	2.069	1	06:58:14.70p.m.	06:58:14.70p.m.	1	1
	2	car	1.268	1	6:02:39.31p.m.	6:02:39.31p.m.	1	1
	2	car	1.468	1	09:51:11.91p.m.	09:51:11.91p.m.	1	1
	2	car	1.162	1	10:18:00.44p.m.	10:18:00.44p.m.	1	1

Table A69. One Month After Study at Intersection of US-69 & 95th Street East (24 hours) 15th October 2014

Comments	Number of vehicle	US69 & 95th (E)						
		Type of vehicle	Seconds into red (sec)	Northbound Approach	Time of Day (a.m.)	Time on video	Violations per lane	Violation Configuration
	Code			Inner Left lane				
Never Stopped	3	pick up truck	300+	1	1:59:30.35a.m.	1:59:30.35a.m.	1	1
Never Stopped	3	pickup truck	300+	1	3:23:36.80a.m.	3:23:36.80a.m.	1	1
Never Stopped	3	pick up truck	300+	1	4:42:38.90a.m.	4:42:38.90a.m.	1	1
	2	car	1.668	1	6:03:17.27a.m.	6:03:17.27a.m.	1	1
	2	car	300+	1	8:13:29.57a.m.	8:13:29.57a.m.	1	1
	2	car	1.508	1	8:32:28.36a.m.	8:32:28.36a.m.	1	1
U turn Car doesn't stop	2	car	300+	1	8:57:18.26a.m.	8:57:18.26a.m.	1	1
	2	car	300+	1	10:24:30.83a.m.	10:24:30.83a.m.	1	1
	2	car	2.174	1	12:52:36.68p.m.	12:52:36.68p.m.	1	1
	2	car	2.402	1	6:09:58.17p.m.	6:09:58.17p.m.	1	1
	2	car	2.665	1	6:14:28.75p.m.	6:14:28.75p.m.	1	1
	2	car	1.469	1	6:15:57.10p.m.	6:15:57.10p.m.	1	1
	2	car	1.335	1	7:11:26.32p.m.	7:11:26.32p.m.	1	1
	2	car	3.131	1	7:11:28.12p.m.	7:11:28.12p.m.	1	1
	2	car	2.336	1	8:36:51.20p.m.	8:36:51.20p.m.	1	1
	2	car	1.735	1	06:52:14.70p.m.	06:52:14.70p.m.	1	1
	2	car	2.069	1	06:58:14.70p.m.	06:58:14.70p.m.	1	1
	2	car	1.268	1	6:02:39.31p.m.	6:02:39.31p.m.	1	1
	2	car	1.468	1	09:51:11.91p.m.	09:51:11.91p.m.	1	1
	2	car	1.162	1	10:18:00.44p.m.	10:18:00.44p.m.	1	1

Table A70. One Month After Study at Intersection of US-69 & 95th Street East (24 hours) 16th October 2014

Comments	Number of vehicle	US69 & 95th (E)						
		Type of vehicle	Seconds into red (sec)	Northbound	Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane				
Never Stopped	2	car	300+	1	2:29:27.85a.m.	2:29:27.85a.m.	1	1
Heavy truck pulling two units	5	truck	300+	1	4:30:52.40a.m.	4:30:52.40a.m.	1	1
	2	car	300+	1	4:37:50.36a.m.	4:37:50.36a.m.	1	1
	2	car	1.868	1	6:03:16.92a.m.	6:03:16.92a.m.	1	1
	2	car	300+	1	6:28:25.33a.m.	6:28:25.33a.m.	1	1
	2	car	300+	1	6:37:48.82a.m.	6:37:48.82a.m.	1	1
	2	car	1.802	1	6:38:17.05a.m.	6:38:17.05a.m.	1	1
	2	car	2.135	1	6:51:56.19a.m.	6:51:56.19a.m.	1	1
	2	car	1.357	1	8:30:57.54a.m.	8:30:57.54a.m.	1	1
	2	car	2.202	1	8:32:28.54a.m.	8:32:28.54a.m.	1	1
	2	car	1.135	1	9:02:27.46a.m.	9:02:27.46a.m.	1	1
	2	car	2.002	1	9:39:58.60a.m.	9:39:58.60a.m.	1	1
	5	truck	2.804	1	9:54:59.37a.m.	9:54:59.37a.m.	1	1
	2	car	3.438	1	10:01:59.18a.m.	10:01:59.18a.m.	1	1
	2	car	1.802	1	11:06:58.28a.m.	11:06:58.28a.m.	1	1
	2	car	1.935	1	12:50:53.63a.m.	12:50:53.63a.m.	1	1
	2	car	300+	1	1:41:34.69p.m.	1:41:34.69p.m.	1	1
	2	car	2.193	1	1:52:04.50p.m.	1:52:04.50p.m.	1	1
	3	pick up truck	300+	1	2:41:40.18p.m.	2:41:40.18p.m.	1	1
	2	car	1.402	1	5:00:42.73p.m.	5:00:42.73p.m.	1	1
	3	truck	1.335	1	5:18:51.78p.m.	5:18:51.78p.m.	1	1
	2	car	3.07	1	5:22:24.15p.m.	5:22:24.15p.m.	1	1
	6	Recreational Vehicle	1.545	1	5:34:30.15p.m.	5:34:30.15p.m.	1	1
	2	car	2.326	1	6:10:14.85p.m.	6:10:14.85p.m.	1	1
	2	car	2.47	1	6:47:44.54p.m.	6:47:44.54p.m.	1	1
	3	pick up truck	2.603	1	6:50:44.52p.m.	6:50:44.52p.m.	1	1
	2	car	1.469	1	6:52:13.15p.m.	6:52:13.15p.m.	1	1
	2	car	300+	1	6:56:05.78p.m.	6:56:05.78p.m.	1	1
	2	car	2.536	1	8:29:43.63p.m.	8:29:43.63p.m.	1	1
	2	car	2.336	1	9:08:14.20p.m.	9:08:14.20p.m.	1	1
	2	car	2.866	1	11:45:06.94p.m.	11:45:06.94p.m.	1	1

One Month After Study Volume

Control Sites

I-435 & Anticoh North

Table A71. 14th October 2014

Time	Volume	
	Inner	Outer
12-2a.m.	8	8
2-3a.m.	4	4
5-6 a.m.	Angle Changed	
6-7a.m.	55	45
7-9a.m.	158	163
9-12p.m.	150	170
12-2p.m.	122	115
2-4p.m.	100	127
4-6p.m.	124	144
6-8P.m.	9	18
8-10p.m.	Angle Changed	
10-12a.m.		

Table A72. 15th October

Time	Volume	
	Inner	Outer
12-6a.m.	Camera Angle Changed	
6-7a.m.	54	63
7-9a.m.	154	136
9-12p.m.	169	150
12-2p.m.	189	131
2-4p.m.	145	123
4-6p.m.	130	126
6-8P.m.	104	96
8-10p.m.	62	53
10-12a.m.	29	37

Table A73. 16th October

Time	Volume	
	Inner	Outer
12-2a.m.	angle changed	
2-5a.m.		
6-7a.m.	57	43
7-9a.m.	146	156
9-12p.m.	115	162
12-2p.m.	87	140
2-4p.m.	117	152
4-6p.m.	117	137
6-8P.m.	94	97
8-10p.m.	47	71
10-12a.m.	36	45

I-435 & Antioch South

Table A74. 14th October 2014

Time	Volume	
	Inner	Outer
12-2a.m.	16	14
2-5a.m.	11	7
5-7a.m.	186	153
7-9a.m.	561	550
9-12p.m.	674	562
12-2p.m.	544	415
2-4p.m.	673	569
4-6p.m.	1157	1057
6-8P.m.	460	383
8-10p.m.	159	110
10-12a.m.	70	63

Table A75. 15th October 2014

Time	Volume	
	Inner	Outer
12-2a.m.	14	17
2-5a.m.	37	20
5-7a.m.	180	147
7-9a.m.	595	553
9-12p.m.	625	503
12-2p.m.	539	463
2-4p.m.	654	549
4-6p.m.	970	870
6-8P.m.	400	340
8-10p.m.	160	127
10-12a.m.	57	42

Table A76. 16th October 2014

Time	Volume	
	Inner	Outer
12-2a.m.	24	18
2-4a.m.	33	22
4-7a.m.	215	151
7-9a.m.	567	529
9-12p.m.	721	604
12-2p.m.	549	459
2-4p.m.	609	533
4-6p.m.	1159	1096
6-8P.m.	377	341
8-10p.m.	207	143
10-12a.m.	81	66

I-435 & Metcalf Avenue

Table A77. 14th October 2014

Time	Volume	
	Inner	Outer
12-9:45a.m.	Camera Angle Changed	
9:45a.m.-12p.m.	687	409
12-2p.m.	669	357
2-4p.m.	950	462
4-5p.m.	598	335
5-6p.m.	608	290
6-8p.m.	652	312
8-10p.m.	303	166
10-12a.m.	227	114

Table A78. 15th October 2014

Time	Volume	
	Inner	Outer
12-2a.m.	94	50
2-5a.m.	36	15
5-7a.m.	176	58
7-9a.m.	505	365
9-12p.m.	802	470
12-2p.m.	692	385
2-4p.m.	961	535
4-5:30p.m.	809	475
5:30-6 P.m.	Camera Angle Changed	
6-8p.m.	635	313
8-10p.m.	386	250
10-12a.m.	179	110

Table A79. 16th October 2014

Time	Volume	
	Inner	Outer
12-2a.m.	102	51
2-5a.m.	46	17
5-7a.m.	177	89
7-9a.m.	501	382
9-12p.m.	640	368
12-2p.m.	700	397
2-4p.m.	899	510
4-6p.m.	1189	647
6-8P.m.	702	370
8-10p.m.	486	264
10-12a.m.	179	86

US-69 & 95th Street West

Table A80. 14th October 2014

Time	Volume
12- 2a.m.	9
2- 4 a.m.	7
4- 5a.m.	4
5- 7a.m.	75
7- 9a.m.	206
9-12a.m.	198
12-2p.m.	248
2-4p.m.	287
4-6p.m.	275
6-8p.m.	248
8-10p.m.	180
10-12p.m.	45

Table A81. 15th October 2014

Time	Volume
12- 2a.m.	7
2- 4 a.m.	5
4- 5a.m.	7
5- 7a.m.	79
7- 9a.m.	180
9-12a.m.	214
12-2p.m.	289
2-4p.m.	257
4-6p.m.	229
6-8p.m.	260
8-10P.m.	212
10-12p.m.	64

Table A82. 16th October 2014

Time	Volume
12- 2a.m.	13
2- 4 a.m.	12
4- 5a.m.	6
5- 7a.m.	76
7- 9a.m.	217
9-12a.m.	237
12-2p.m.	300
2-4p.m.	292
4-6p.m.	288
6-8p.m.	253
8-10p.m.	255
10-12p.m.	68

US 69 & 95th Street East

Table A83. 14th October 2014

Time	Volume
12- 2a.m.	14
2- 4 a.m.	12
4- 5a.m.	11
5- 7a.m.	181
7- 9a.m.	554
9-12a.m.	390
12-2p.m.	324
2-4p.m.	329
4-6p.m.	397
6-8p.m.	316
8-10p.m.	164
10-12p.m.	124

Table A84. 15th October 2014

Time	Volume
12- 2a.m.	23
2- 4 a.m.	12
4- 5a.m.	11
5- 7a.m.	175
7- 9a.m.	543
9-12a.m.	394
12-1:20p.m.	143
6-8p.m.	280
8-10p.m.	190
10-12p.m.	69

Table A85. 16th October 2014

Time	Volume
12- 2a.m.	21
2- 4 a.m.	14
4- 5a.m.	15
5- 7a.m.	186
7- 9a.m.	532
9-12a.m.	350
12-2p.m.	294
2-4p.m.	306
4-6p.m.	366
6-8p.m.	286
8-10p.m.	204
10-12p.m.	87

THREE MONTH AFTER STUDY RLR VIOLATIONS

Treatment Sites

Table A86. Three Month After Study at Intersection of I-435 & Quivera North (24 hours) 16th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Quivera N							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
Didn't stop	2	Passenger Car	300	1		4:45:25.938a.m.	4:45:25.938a.m.	1	1
	2	Passenger Car	1.5	1		2:15:58.220p.m.	2:15:58.220p.m.	1	1
	2	Passenger Car	2		1	4:09:58.067p.m.	4:09:58.067p.m.	1	1
	2	Passenger Car	2.9		1	4:39:21.346p.m.	4:39:21.346p.m.	1	1
	2	Passenger Car	2.4		1	6:48:00.031p.m.	6:48:00.031p.m.	1	1
	2	Passenger Car	300	1		7:39:23.700p.m.	7:39:23.700p.m.	1	1

Table A87. Three Month After Study at Intersection of I-435 & Quivera North (24 hours) 17th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Quivera N							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	2.4		1	9:17:52.721a.m.	9:17:52.721a.m.	1	1
	2	Passenger Car	1.7	1		1:51:58.312p.m.	1:51:58.312p.m.	1	1
	2	Passenger Car	2.8		1	2:39:57.016p.m.	2:39:57.016p.m.	1	1
	2	Passenger Car	2.4	1		2:53:57.308p.m.	2:53:57.308p.m.	1	1
	2	Passenger Car	1.8	1		3:43:55.878p.m.	3:43:55.878p.m.	1	1
	2	Passenger Car	1.8	1		3:57:55.363p.m.	3:57:55.363p.m.	1	1
Ran Together	2	Passenger Car	2.2	1		4:44:01.613p.m.	4:44:01.613p.m.	1	2
	2	Passenger Car	3.8		1	4:44:01.613p.m.	4:44:01.613p.m.	1	2

Table A88. Three Month After Study at Intersection of I-435 & Quivera North (24 hours) 18th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Quivera N							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	49		1	12:33:52.590a.m.	12:33:52.590a.m.	1	1
	2	Passenger Car	1	1		4:52:07.672a.m.	4:52:07.672a.m.	1	1
	2	Passenger Car	1.9	1		10:12:55.534a.m.	10:12:55.534a.m.	1	1
	2	Passenger Car	2.8		1	1:21:58.924p.m.	1:21:58.924p.m.	1	1
	2	Passenger Car	1.9			2:01:58.190p.m.	2:01:58.190p.m.	1	1
	2	Passenger Car	2.7	1		4:03.:58.587p.m.	4:03.:58.587p.m.	1	1
	2	Passenger Car	4.3	1		5:12:00.9692p.m.	5:12:00.9692p.m.	1	1

Table A89. Three Month After Study at Intersection of I-435 & Quivera South (24 hours) 16th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Quivera S							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	22		1	4:42:20.352a.m.	4:42:20.352a.m.	1	1
	2	Passenger Car	1.7	1		7:58:16.946a.m.	7:58:16.946a.m.	1	1
	2	Passenger Car	3	1		9:15:11.997a.m.	9:15:11.997a.m.	1	1
	2	Passenger Car	3.3	1		4:48:05.275p.m.	4:48:05.275p.m.	1	1
	2	Passenger Car	2.4	1		6:25:09.565p.m.	6:25:09.565p.m.	1	1

Table A90. Three Month After Study at Intersection of I-435 & Quivera South (24 hours) 17th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Quivera S							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
Didn't Even stop	2	Passenger Car	14.12		1	4:33:00.995a.m.	4:33:00.995a.m.	1	1
	2	Passenger Car	2.6		1	7:36:17.679a.m.	7:36:17.679a.m.	1	1
	2	Passenger Car	2.2		1	7:76:17.435a.m.	7:76:17.435a.m.	1	1
	2	Passenger Car	1.7		1	7:54:17.520a.m.	7:54:17.520a.m.	1	1
	5	Truck	2.5	1		1:43:07.387p.m.	1:43:07.387p.m.	1	1
	2	Passenger Car	2.1	1		6:21:09.624p.m.	6:21:09.624p.m.	1	1

Table A91. Three Month After Study at Intersection of I-435 & Quivera South (24 hours) 18th December 2014

Any Comment or Confusion mention here.	Number of vehicle	Type of vehicle	I-435 & Quivera S						
			Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
Didn't Stop	5	Truck	14	1		3:23:42.315a.m.	3:23:42.315a.m.	1	1
	3	Pick up	69.2	1		3:54:22.229a.m.	3:54:22.229a.m.	1	2
	5	Truck	69.2		1	3:54:22.229a.m.	3:54:22.229a.m.	1	2
	2	Passenger Car	18.7	1		3:59:41.373a.m.	3:59:41.373a.m.	1	1
	3	Pick up	39.5		1	5:02:20.587a.m.	5:02:20.587a.m.	1	1
	2	Passenger Car	2.6	1		7:40:17.013a.m.	7:40:17.013a.m.	1	1
	2	Passenger Car	2.2	1		8:48:54.437a.m.	8:48:54.437a.m.	1	1
	2	Passenger Car	3	1		6:43:06.162p.m.	6:43:06.162p.m.	1	1

Volumes

Treatment Sites

I-435 & Quivera North

Table A92. 16th December 2014

Time	Volume	
	Inner	Outer
12-2a.m.	23	5
2-5a.m.	19	10
5-7a.m.	109	46
7-9a.m.	350	242
9-12p.m.	487	262
12-2p.m.	448	255
2-4p.m.	505	313
4-6p.m.	428	273
6-8P.m.	319	181
8-10p.m.	171	106
10-12a.m.	59	28

Table A93. 17th December 2014

Time	Volume	
	Inner	Outer
12-2a.m.	20	6
2-5a.m.	15	7
5-7a.m.	109	51
7-9a.m.	324	182
9-12p.m.	421	253
12-2p.m.	408	251
2-4p.m.	515	345
4-6p.m.	461	297
6-8P.m.	322	187
8-10p.m.	238	127
10-12a.m.	64	32

Table A94. 18th December 2014

Time	Volume	
	Inner	Outer
12-2a.m.	28	8
2-5a.m.	17	8
5-7a.m.	86	34
7-9a.m.	280	158
9-12p.m.	384	234
12-2p.m.	365	211
2-4p.m.	409	270
4-6p.m.	428	325
6-8P.m.	308	160
8-12a.m.	318	174
10-12a.m.	Camera Angle Changed	

I-435 & Quivera South

Table A95. 16th December 2014

Time	Volume	
	Inner	Outer
12-2a.m.	12	13
2-5a.m.	23	19
5-7A.m.	175	87
7-9a.m.	458	286
9-12p.m.	397	251
12-2p.m.	256	201
2-4p.m.	326	203
4-6p.m.	487	293
6-8p.m.	270	189
8-10p.m.	143	120
10-12a.m.	185	164

Table A96. 17th December 2014

Time	Volume	
	Inner	Outer
12-2a.m.	20	23
2-5a.m.	26	23
5-7A.m.	156	86
7-9a.m.	460	280
9-12p.m.	429	277
12-2p.m.	306	219
2-6p.m.	Camera Angle changed	
6-8p.m.	253	152
8-10p.m.	179	121
10-12a.m.	129	117

Table A97. 18th December 2014

Time	Volume	
	Inner	Outer
12-2A.m.	23	14
2-5A.m.	29	17
5-7a.m.	160	75
7-9a.m.	398	223
9-12p.m.	375	251
12-2p.m.	69	47
2-6p.m.	Camera Angle Changed	
6-8p.m.	228	144
8-10p.m.	176	120
10-12A.m.	70	60

CONTROL SITES

Table A98. Three Months After Study at Intersection of I-435 & Antioch North (24 hours) 16th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & AntiochN							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	38.4		1	6:35:45.138a.m.	6:35:45.138a.m.	1	1
	2	Passenger Car	2.3		1	6:37:09.466a.m.	6:37:09.466a.m.	1	1
	2	Passenger Car	3.2		1	6:47:38.226a.m.	6:47:38.226a.m.	1	1
	2	Passenger Car	3.8	1		6:53:46.201a.m.	6:53:46.201a.m.	1	1
	2	Passenger Car	2.8	1		10:16:09.874a.m.	10:16:09.874a.m.	1	1
	2	Passenger Car	1.6	1		1:15:50.638p.m.	1:15:50.638p.m.	1	1
	2	Passenger Car	1.7	1		2:14:58.006p.m.	2:14:58.006p.m.	1	1
	2	Passenger Car	1.6	1		2:38:12.983p.m.	2:38:12.983p.m.	1	1
	2	Passenger Car	1.8	1		3:08:21.111p.m.	3:08:21.111p.m.	1	1
	2	Passenger Car	0.7	1		7:28:39.363p.m.	7:28:39.363p.m.	1	1

Table A99. Three Months After Study at Intersection of I-435 & Antioch North (24 hours) 17th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & AntiochN							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	2.8		1	12:47:40.480p.m.	12:47:40.480p.m.	1	1
	2	Passenger Car	1.8	1		12:55:49.114p.m.	12:55:49.114p.m.	1	1
	2	Passenger Car	2		1	1:29:49.382p.m.	1:29:49.382p.m.	1	1

Table A100. Three Months After Study at Intersection of I-435 & Antioch North (24 hours) 18th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & AntiochN							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	154.6		1	12:21:14.959a.m.	12:21:14.959a.m.	1	1
	2	Passenger Car	2.3	1		9:46:16.931a.m.	9:46:16.931a.m.	1	1
	2	Passenger Car	1.8		1	9:46:16.603a.m.	9:46:16.603a.m.	1	2
Ran Together	2	Passenger Car	4	1		9:46:16.603a.m.	9:46:16.603a.m.	1	2

Table A101. Three Months After Study at Intersection of I-435 & Antioch South (24 hours) 16th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Antioch S							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
Didn't Stop	2	Passenger Car	300+	1		12:43:45.523a.m.	12:43:45.523a.m.	1	1
	2	Passenger Car	2.2	1		12:40:46.359a.m.	12:40:46.359a.m.	1	1
	2	Passenger Car	2.6		1	3:07:36.791p.m.	3:07:36.791p.m.	1	1
	2	Passenger Car	4.3	1		4:15:23.029p.m.	4:15:23.029p.m.	1	1
	2	Passenger Car	2		1	4:17:22.969p.m.	4:17:22.969p.m.	1	1
	2	Passenger Car	1.5	1		4:23:13.451p.m.	4:23:13.451p.m.	1	1
	2	Passenger Car	1.4	1		4:32:33.213p.m.	4:32:33.213p.m.	1	1
	2	Passenger Car	1.6	1		7:19:42.509p.m.	7:19:42.509p.m.	1	1

Table A102. Three Months After Study at Intersection of I-435 & Antioch South (24 hours) 17th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Antioch S							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	2.1	1		9:14:02.192a.m.	9:14:02.192a.m.	1	1
	2	Passenger Car	2.1		1	11:05:52.504a.m.	11:05:52.504a.m.	1	1
	2	Passenger Car	2.8	1		3:05:53.772p.m.	3:05:53.772p.m.	1	1
	2	Passenger Car	0.5		1	3:55:19.557p.m.	3:55:19.557p.m.	1	1
	3	Pick Up	2.1		1	6:15:01.257p.m.	6:15:01.257p.m.	1	1
	3	Pick Up	2.8	1		6:17:34.725p.m.	6:17:34.725p.m.	1	1
Ran Together	2	Passenger Car	2.9		1	7:11:15.687p.m.	7:11:15.687p.m.	1	2
	2	Passenger Car	2.9	1		7:11:15.687p.m.	7:11:15.687p.m.	1	2
	2	Passenger Car	31	1		7:22:05.052p.m.	7:22:05.052p.m.	1	1

Table A103. Three Months After Study at Intersection of I-435 & Antioch South (24 hours) 18th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Antioch S							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	300	1		6:01:15.024a.m.	6:01:15.024a.m.	1	1
Ran togther	2	Passenger Car	180		1	6:06:44.241a.m.	6:06:44.241a.m.	1	2
	2	Passenger Car	180	1		6:06:44.241a.m.	6:06:44.241a.m.	1	2
	2	Pickup	226	1					
	2	Passenger Car	3.1		1	10:33:31.960a.m.	10:33:31.960a.m.	1	1
	2	Passenger Car	2.6	1		10:45:31.595a.m.	10:45:31.595a.m.	1	1
Ran Together	2	Passenger Car	2		1	3:37:33.596p.m.	3:37:33.596p.m.	1	2
	2	Passenger Car	2	1		3:37:33.596p.m.	3:37:33.596p.m.	1	2
	2	Passenger Car	5.2	1		3:37:33.596p.m.	3:37:33.596p.m.	1	1
	2	Passenger Car	2.4	1		6:39:12.775p.m.	6:39:12.775p.m.	1	1
	2	Passenger Car	2.6	1		7:59:12.596p.m.	7:59:12.596p.m.	1	1
	2	Passenger Car	2.8	1		8:24:24.720p.m.	8:24:24.720p.m.	1	1

Table A104. Three Month Study at Intersection of I-435 & Metcalf Avenue North (24 hours) 16th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 & Metcalf							
		Type of vehicle	Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	2.7		1	7:39:10.749a.m.	7:39:10.749a.m.	1	1
	2	Passenger Car	2	1		8:11:50.610a.m.	8:11:50.610a.m.	1	1
	2	Passenger Car	2.1	1		8:14:11.202a.m.	8:14:11.202a.m.	1	1
	2	Passenger Car	1.8	1		10:36:40.082a.m.	10:36:40.082a.m.	1	1
	2	Passenger Car	2		1	2:11:37.189p.m.	2:11:37.189p.m.	1	1
	2	Passenger Car	2		1	2:15:49.770p.m.	2:15:49.770p.m.	1	1
	2	Passenger Car	2.5	1		3:16:45.224p.m.	3:16:45.224p.m.	1	1
	2	Passenger Car	1.6	1		3:37:45.128p.m.	3:37:45.128p.m.	1	1
	2	Passenger Car	3	1		3:56:39.583p.m.	3:56:39.583p.m.	1	1
	2	Passenger Car	2.2	1		4:40:58.859p.m.	4:40:58.859p.m.	1	1
	2	Passenger Car	2.1	1		4:45:39.068p.m.	4:45:39.068p.m.	1	1
	2	Passenger Car	2.8	1		4:54:58.810p.m.	4:54:58.810p.m.	1	1
	2	Passenger Car	2.5	1		5:22:59.323p.m.	5:22:59.323p.m.	1	1
	2	Passenger Car	2.6		1	5:25:18.861p.m.	5:25:18.861p.m.	1	1
	2	Passenger Car	3.1	1		8:08:05.707p.m.	8:08:05.707p.m.	1	1

Table A105. Three Month Study at Intersection of I-435 & Metcalf Avenue North (24 hours) 17th December 2014

Any Comment or Confusion mention here.	Number of vehicle	I-435 &Metcalf							
		Type of vehicle	Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	150.5	1		3:13:18.585a.m.	3:13:18.585a.m.	1	1
	2	Passenger Car	2.1	1		8:23:31.285a.m.	8:23:31.285a.m.	1	1
Ran Together	2	Passenger Car	2.6	1		10:20:49.546a.m.	10:20:49.546a.m.	2	3
	2	Passenger Car	2.9	1		10:20:49.546a.m.	10:20:49.546a.m.	2	3
	2	Passenger Car	1.4	1		10:30:17.706a.m.	10:30:17.706a.m.	1	1
	2	Passenger Car	3	1		1:04:24.503a.m.	1:04:24.503a.m.	1	1
	2	Passenger Car	1.2	1		2:36:48.496p.m.	2:36:48.496p.m.	1	1
	2	Passenger Car	1.8	1		2:49:24.009p.m.	2:49:24.009p.m.	1	1
	2	Passenger Car	2.7		1	3:06:12.432p.m.	3:06:12.432p.m.	1	1
Ran Together	2	Passenger Car	1.6	1		3:16:41.922p.m.	3:16:41.922p.m.	2	3
	2	Passenger Car	2.8	1		3:16:41.922p.m.	3:16:41.922p.m.	2	3
	2	Passenger Car	2		1	3:33:30.317p.m.	3:33:30.317p.m.	1	1
	3	Pick-up Truck	2	1		3:52:24.455p.m.	3:52:24.455p.m.	1	1
	2	Passenger Car	2.6	1		4:05:355.321p.m.	4:05:55.321p.m.	1	1
	2	Passenger Car	3.2		1	4:29:14.885p.m.	4:29:14.885p.m.	1	1
	2	Passenger Car	2.3	1		5:15:55.165p.m.	5:15:55.165p.m.	1	1

Table A106. Three Month Study at Intersection of I-435 & Metcalf Avenue North (24 hours) 18th December October 2014

Any Comment or Confusion mention here.	Number of vehicle	Type of vehicle	I-435 & Metcalf						
			Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Pssenger Car	2	1		7:20:29.279a.m.	7:20:29.279a.m.	1	1
	2	Pssenger Car	2.1	1		7:34:29.570a.m.	7:34:29.570a.m.	1	1
	2	Passenger Car	2.1	1		8:14:09.246a.m.	8:14:09.246a.m.	1	1
	2	Passenger Car	2.3		1	10:28:40.894a.m.	10:28:40.894a.m.	1	1
	2	Passenger Car	2		1	12:11:54.888p.m.	12:11:54.888p.m.	1	1
	2	Passenger Car	2.2		1	12:26:36.441p.m.	12:26:36.441p.m.	1	1
	2	Passenger Car	3	1		1:04:23.701p.m.	1:04:23.701p.m.	1	1
Ran Together	2	Passenger Car	1.7	1		2:44:26.556p.m.	2:44:26.556p.m.	1	2
	2	Passenger Car	3.1		1	2:44:26.556p.m.	2:44:26.556p.m.	1	2
	2	Passenger Car	4.3		1	2:55:41.779p.m.	2:55:41.779p.m.	1	1
	2	Passenger Car	2.7		1	3:35:36.141p.m.	3:35:36.141p.m.	1	1
	2	Passenger Car	3		1	3:39:47.792p.m.	3:39:47.792p.m.	1	1
	2	Passenger Car	2	1		3:52:23.771p.m.	3:52:23.771p.m.	1	1
	2	Passenger Car	1.7	1		4:57:14.539p.m.	4:57:14.539p.m.	1	1
	2	Passenger Car	2.1		1	5:01:54.451p.m.	5:01:54.451p.m.	1	1
	2	Passenger Car	2.2		1	5:27:34.410p.m.	5:27:34.410p.m.	1	2
	2	Passenger Car	3.6	1		5:27:34.410p.m.	5:27:34.410p.m.	1	2
	2	Passenger Car	2.5		1	6:07:14.247p.m.	6:07:14.247p.m.	1	1

Table A107. Three Month After Study at Intersection of US-69 & 95th Street West (24 hours) 16th December 2014

Any Comment or Confusion mention here.	Number of vehicle	Type of vehicle	US69W						
			Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	15.4	1		8:42:10.617a.m.	8:42:10.617a.m.	1	1
	2	Passenger Car	113	1		9:40:47.079a.m.	9:40:47.079a.m.	1	1
	2	Passenger Car	51.3	1		9:47:57.676a.m.	9:47:57.676a.m.	1	1
	2	Passenger Car	3.6	1		12:08:16.693a.m.	12:08:16.693a.m.	1	1
	2	Passenger Car	3.6	1		12:55:13.170a.m.	12:55:13.170a.m.	1	1
	2	Passenger Car	3.1	1		1:38:33.314a.m.	1:38:33.314a.m.	1	1
	2	Passenger Car	2.1	1		3:38:24.021p.m.	3:38:24.021p.m.	1	1
	2	Passenger Car	2.4	1		4:25:09.505p.m.	4:25:09.505p.m.	1	1
	2	Passenger Car	2	1		5:05:15.289p.m.	5:05:15.289p.m.	1	1
	2	Passenger Car	12.7	1		9:47:15.138p.m.	9:47:15.138p.m.	1	1

Table A108. Three Month After Study at Intersection of US-69 & 95th Street West (24 hours) 17th December 2014

Any Comment or Confusion mention here.	Number of vehicle	Type of vehicle	US69W						
			Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	300	1					
	2	Passenger Car	2.2	1		12:49:59.106p.m.	12:49:59.106p.m.	1	1
	2	Passenger Car	2.2	1		12:55:11.595p.m.	12:55:11.595p.m.	1	1
	4	Bus	2.1	1		1:53:31.711p.m.	1:53:31.711p.m.	1	1

Table A109. Three Month After Study at Intersection of US-69 & 95th Street West (24 hours) 18th December 2014

Any Comment or Confusion mention here.	Number of vehicle	Type of vehicle	US69W						
			Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	197	1		7:08:15.322a.m.	7:08:15.322a.m.	1	1
	2	Passenger Car	2.1	1		9:30:04.933a.m.	9:30:04.933a.m.	1	1
	2	Passenger Car	88.5	1		10:10:34.766a.m.	10:10:34.766a.m.	1	1
	2	Passenger Car	30	1		10:43:44.145a.m.	10:43:44.145a.m.	1	1
	2	Passenger Car	2.5	1		12:36:40.637p.m.	12:36:40.637p.m.	1	1
	2	Passenger Car	2.2	1		2:05:11.731p.m.	2:05:11.731p.m.	1	1
	2	Passenger Car	2.6	1		3:48:31.380a.m.	3:48:31.380a.m.	1	1
Ran Together	2	Passenger Car	1.9	1		6:10:45.434p.m.	6:10:45.434p.m.	2	3
	2	Passenger Car	4	1		6:10:45.434p.m.	6:10:45.434p.m.	2	3
	2	Passenger Car	151.3	1		7:30:06.694p.m.	7:30:06.694p.m.	1	1

Table A110. Three Month After Study at Intersection of US-69 & 95th Street East (24 hours) 16th December 2014

Any Comment or Confusion mention here.	Number of vehicle	Type of vehicle	US69E						
			Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	1.8	1		10:46:08.542a.m.	10:46:08.542a.m.	1	1

Table A111. Three Month After Study at Intersection of US-69 & 95th Street East (24 hours) 17th December 2014

Any Comment or Confusion mention here.	Number of vehicle	Type of vehicle	US69E						
			Seconds into red	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	2.7	1		7:44:36.797a.m.	7:44:36.797a.m.	1	1
	2	Passenger Car	3	1		7:49:36.367a.m.	7:49:36.367a.m.	1	1
	2	Passenger Car	2.7	1		8:37:09.639a.m.	8:37:09.639a.m.	1	1
	2	Passenger Car	2.1	1		8:52:09.700a.m.	8:52:09.700a.m.	1	1

Table A112. Three Month After Study at Intersection of US-69 & 95th Street East (24 hours) 18th December 2014

Any Comment or Confusion mention here.	Number of vehicle	Type of vehicle	US69E						
			Seconds into red (sec)	Northbound Approach (Left)		Time of Day (a.m.)	Time on video	Violations per lane	Violation Configurations
	Code			Inner Left lane	Outer left lane				
	2	Passenger Car	23.9	1		5:10:42.913a.m.	5:10:42.913a.m.	1	1

Volumes

Control Sites

I-435 & Antioch North

Table A113. 16th December 2014

Time	Volume	
	Inner	Outer
12-2a.m.	10	8
2-5a.m.	15	17
5-7a.m.	66	72
7-9a.m.	197	188
9-12p.m.	138	145
12-2p.m.	112	105
2-4p.m.	118	107
4-6p.m.	129	113
6-8P.m.	101	88
8-12a.m.	Camera Angle Changed	

Table A114. 17th December 2014

Time	Volume	
	Inner	Outer
12-6a.m.	Ca.m.era Angle Changed	
6-7a.m.	48	49
7-9a.m.	198	198
9-12p.m.	195	146
12-2p.m.	134	107
2-4p.m.	135	113
4-5:15p.m.	94	87
5:15-6p.m.	Ca.m.era Angle Changed	
6-8P.m.	106	91
8-10p.m.	60	52
10-12a.m.	31	14

Table A115. 18th December 2014

Time	Volume	
	Inner	Outer
12-2a.m.	6	6
2-5a.m.	3	18
5-7a.m.	36	51
7-9a.m.	124	136
9-12p.m.	170	130
12-2p.m.	95	88
2-4p.m.	112	94
4-6p.m.	127	102
6-8P.m.	87	82
8-10p.m.	69	40
10-12a.m.	27	26

I-435 & Antioch South

Table A116. 16th December 2014

Time	Volume	
	Inner	Outer
12-2a.m.	15	8
2-5a.m.	11	8
5-7a.m.	108	99
7-9a.m.	346	334
9-12p.m.	483	411
12-2p.m.	340	336
2-4p.m.	435	378
4-6p.m.	872	813
6-8P.m.	340	272
8-10p.m.	151	118
10-12a.m.	60	46

Table A117. 17th December 2014

Time	Volume	
	Inner	Outer
12-2a.m.	16	16
2-5a.m.	20	15
5-7a.m.	113	89
7-9a.m.	346	326
9-12p.m.	466	460
12-2p.m.	367	312
2-4p.m.	438	386
4-6p.m.	864	769
6-8P.m.	305	251
8-10p.m.	126	130
10-12a.m.	38	40

Table A118. 18th December 2014

Time	Volume	
	Inner	Outer
12-6a.m.	Camera Angle Changed	
6-7a.m.	61	60
7-9a.m.	254	248
9-12p.m.	407	418
12-2p.m.	356	324
2-4p.m.	437	356
4-6p.m.	830	120
6-8P.m.	315	297
8-10p.m.	126	106
10-12a.m.	37	55

I-435 & Metcalf Avenue North

Table A119. 16th December 2014

Time	Volume	
	Inner	Outer
12-2a.m.	68	37
2-5a.m.	11	5
5-7a.m.	77	33
7-9a.m.	376	214
9-12p.m.	820	521
12-2p.m.	701	386
2-4p.m.	957	472
4-6p.m.	1241	700
6-8P.m.	796	459
8-10p.m.	439	249
10-12a.m.	215	119

Table A120. 17th December 2014

Time	Volume	
	Inner	Outer
12-2a.m.	98	40
2-5a.m.	38	21
5-7a.m.	102	52
7-9a.m.	370	249
9-12p.m.	763	434
12-2p.m.	646	322
2-4p.m.	946	481
4-7p.m.	1678	899
7-8P.m.	273	165
8-10p.m.	388	233
10-12a.m.	174	92

Table A121. 18th December 2014

Time	Volume	
	Inner	Outer
12-12:30a.m.	17	10
12:30-6a.m.	Camera Angle Changed	
6-7a.m.	75	22
7-9a.m.	352	186
9-12p.m.	748	365
12-2p.m.	626	325
2-4p.m.	837	433
4-6p.m.	1156	613
6-8P.m.	689	356
8-10p.m.	399	288
10-12a.m.	176	77

US-69 & 95th Street West

Table A122. 16th December 2014

Time	Volume
	Inner
12-2a.m.	12
2-5a.m.	15
5-7a.m.	78
7-9a.m.	196
9-12p.m.	261
12-2p.m.	326
2-4p.m.	339
4-6p.m.	392
6-8P.m.	325
8-10p.m.	189
10-12a.m.	76

Table A123. 17th December 2015

Time	Volume
	Inner
12-2a.m.	14
2-5a.m.	11
5-7a.m.	81
7-9a.m.	177
9-12p.m.	241
12-2p.m.	373
2-4p.m.	393
4-6p.m.	437
6-8P.m.	352
8-10p.m.	257
10-12a.m.	88

Table A124. 18th December 2014

Time	Volume
	Inner
12-2a.m.	8
2-5a.m.	18
5-7a.m.	67
7-9a.m.	152
9-12p.m.	229
12-2p.m.	256
2-4p.m.	333
4-6p.m.	343
6-8P.m.	376
8-10p.m.	193
10-12a.m.	91

US- 69 & 95th Street East

Table A125. 16th December 2014

Time	Volume
12-2a.m.	17
2-5a.m.	30
5-7a.m.	154
7-9a.m.	492
9-12p.m.	361
12-2p.m.	267
2-4p.m.	288
4-6p.m.	296
6-8P.m.	Bad Camera Light
8-10p.m.	
10-12a.m.	

TableA126. 17th December 2014

Time	Volume
12-2a.m.	14
2-5a.m.	19
5-7a.m.	155
7-9a.m.	520
9-12p.m.	342
12-2p.m.	257
2-4p.m.	287
4-6p.m.	339
6-8P.m.	Bad Camera Light
8-10p.m.	
10-12a.m.	

Table A127. 18th December 2014

Time	Volume
12-2a.m.	20
2-5a.m.	16
5-7a.m.	141
7-9a.m.	262
9-12p.m.	Camera Angle Changed
12-2p.m.	
2-4p.m.	
4-6p.m.	
6-8P.m.	
8-10p.m.	
10-12a.m.	

APPENDIX B

Confirmation Light Specifications

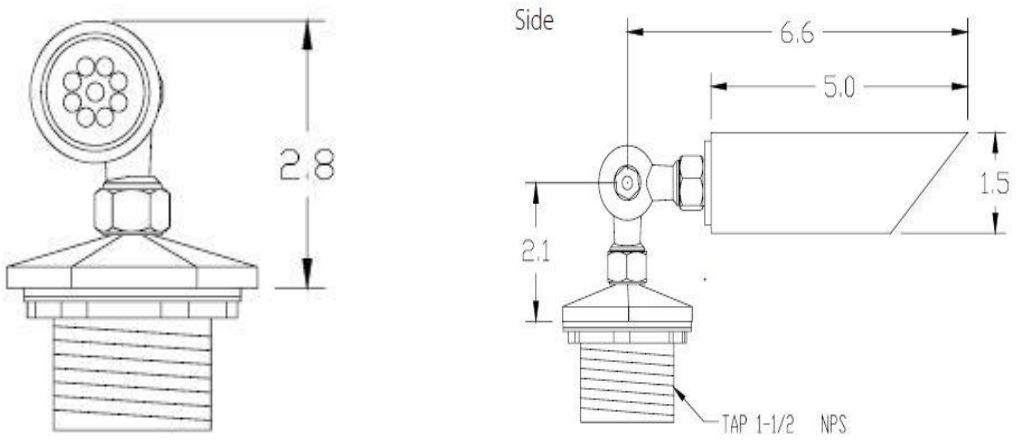


Figure 36. Dimension of McCain Enforcer (Confirmation Lights)

Table B1 outlines the general specifications of the Confira.m.tion light used for this reseach study.(Source: www.mccain-inc.com)

Dimensions	Housing: 5inches long and 1.5 inch dia.m.eter Length including distance to center of elbow: 6.6 inches Height inclusing distance to cap bottom: 2.8 inches
Material	6061-T1 aluminium with 0.125 inches wall thickness
Finishing paint	Powder coated black
Available colors	Red, blue, amber, and white
Input Voltage	20VAC to 150VAC 40Hz to 100Hz
Power	7.2VA (at 110VAC)
Mounting	Standard 1.5 inches NPS orna.m.ental cap/elbow
Enviornmental	Operating temperature -40^{o} C to +85^{o}C Humidity: 0 to 95% (non-condensing)
Weight	1 pound 5ounces